Identified Wildlife Management Strategy

Accounts and Measures for Managing Identified Wildlife

Version 2004

BRITISH COLUMBIA

Ministry of Water, Land and Air Protection

105-04705/

Identified Wildlife Management Strategy

Accounts and Measures for Managing Identified Wildlife

Version 2004

BRITISH
COLUMBIA

Ministry of Water, Land and Air Protection

Preface

The Identified Wildlife Management Strategy is an initiative of the Ministry of Water, Land and Air Protection, in partnership with the Ministry of Forests and carried out in consultation with other resource ministries, stakeholders and the public. Statutory authority is provided for the Ministry of Water, Land and Air Protection to carry out this strategy under provisions of the *Forest Practices Code of British Columbia Act* and regulations, and under the new *Forest and Range Practices Act* and regulations, to be implemented in 2004.

Two companion documents address the management of Identified Wildlife, and together, comprise the Identified Wildlife Management Strategy (IWMS). The first document, *Procedures for Managing Identified Wildlife*, describes the procedures for establishing, modifying and rescinding a wildlife habitat area (WHA), and for implementing strategic and landscape level planning recommendations. This document provides direction to government planners, foresters and wildlife managers.

The second document, *Accounts and Measures for Managing Identified Wildlife*, summarizes the status, life history, distribution and habitats of Identified Wildlife, and outlines specific guidelines for management of their habitats.

These documents are a resource for government planners, foresters and wildlife managers, and for those persons interested in the life histories of Identified Wildlife.

Introduction

Identified Wildlife are species at risk and regionally important wildlife that the Minister of Water, Land and Air Protection designates as requiring special management attention under the Forest and Range Practices legislation. Under this legislation, the definition of species at risk includes endangered, threatened or vulnerable species of vertebrates, invertebrates, plants and plant communities. Regionally important wildlife include species that are considered important to a region of British Columbia, rely on habitats that are not otherwise protected under FRPA, and are vulnerable to forest and range impacts.

The Identified Wildlife Management Strategy (IWMS) provides direction, policy, procedures and guidelines for managing Identified Wildlife. The goals of the Identified Wildlife Management Strategy are to minimize the effects of forest and range practices on Identified Wildlife, and to maintain their critical habitats throughout their current ranges and, where appropriate, their historic ranges. In some cases, this will entail restoration of previously occupied habitats, particularly for those species most at risk.

The Identified Wildlife Management Strategy applies to Crown forest and range land or private land that is subject to a tree farm or woodlot licence. It addresses forest and range practices regulated under British Columbia's forest legislation. It does not address activities such as recreation, hunting, or poaching. Under the *Wildlife Act*, native terrestrial vertebrates designated as "wildlife" are protected from killing, capture, and harassment except by permit or regulation. The strategy also does not address agriculture or urban development. The IWMS is not intended to be a comprehensive recovery strategy; instead it is intended to be one tool that can be used to manage or recover species habitats. A role of the Ministry of Water, Land and Air Protection is to direct or assist in the development of conservation strategies and recovery plans for species at risk. These plans and strategies can address all requirements for a species' conservation including research and inventory needs, habitat conservation, and regulatory measures.

Identified Wildlife are managed through the establishment of wildlife habitat areas (WHAs), objectives for wildlife habitat areas, and implementation of general wildlife measures (GWMs), or through other management practices specified in strategic or landscape level plans. Wildlife habitat areas are mapped areas that have been approved by the Minister of Water, Land and Air Protection as requiring special management. The purpose of WHAs is to conserve those habitats considered most limiting to a given species.

General wildlife measures describe the management practices that must be implemented within an approved WHA or other spatially defined area. A GWM may limit activities partially (e.g., seasonally) or entirely. General wildlife measures prescribe a level of management appropriate to the conservation status of Identified Wildlife. Management objectives are consistent with the goals and commitments of the Canadian Biodiversity Strategy and provincial goals for the management of wildlife (i.e., as outlined in the Provincial Wildlife Strategy).

For the most part, Identified Wildlife provisions do not address the issues of habitat supply, habitat connectivity, and population viability and other issues such as access management. Such issues should be taken into account during strategic or landscape level planning. Species requiring consideration within strategic level plans are typically wide-ranging species that are sensitive to landscape level changes such as, but not limited to, Badger, Caribou, Grizzly Bear, Marbled Murrelet, Queen Charlotte Goshawk, Spotted Owl, and Wolverine.

The management practices included in IWMS are designed to reduce the impacts of forest and range management on Identified Wildlife within targeted social and economic constraints, to balance both socio-economic considerations and conservation of species at risk in British Columbia's managed forest and rangelands. Identified Wildlife Management

Strategy provisions in themselves may be insufficient to conserve viable populations of these species throughout their natural ranges in British Columbia. Other strategies and planning, such as Recovery Plans, may be required. The IWMS is intended to be the single-species complement to the broader, coarse-filter provisions of the province's forest and range practices legislation, and strategic land use plans.

Selection of Category of Species at Risk

Forest practices legislation authorizes the Minister of Water, Land and Air Protection to establish categories of species at risk and regionally important wildlife, for purposes of establishing wildlife habitat areas, objectives and general wildlife measures that make up the IWMS.

On May 3, 2004 the Minister of Water, Land and Air Protection approved 39 species, subspecies and populations for inclusion in the category of species at risk. This category of species at risk represents those species that may be affected by forest and range management on Crown land and are listed by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC), current to November 2002. The species included in this list represent the Identified Wildlife that will form the basis of the Identified Wildlife Management Strategy Version 2004.

An additional list of non-COSEWIC listed provincially red- and blue-listed species have been identified as being negatively affected by forest and range management on Crown land. It is anticipated that these species will be evaluated for inclusion in the category of species at risk and IWMS Version 2004 in the near future.

The Minister of Water, Land and Air Protection has legal authority to establish a category of regionally important wildlife. This category has not been evaluated at this time. It is anticipated that the category of regionally important wildlife will be examined for inclusion in IWMS Version 2004 at a later date.

Account Development and Review

Accounts summarize the status, life history, distribution, habitat requirements and management standards for Identified Wildlife. Accounts were prepared according to IWMS priority (see Selection of Identified Wildlife). The priorities for account development were elements ranked as having a high priority for inclusion in IWMS. Candidates considered of intermediate priority were also considered, particularly those that are listed nationally by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) and those that were originally included within IWMS Volume 1.

Additional accounts will be developed on an ongoing basis according to IWMS priority or national listing (COSEWIC). At this time it is anticipated that updates will be made available annually following updates to national and provincial status listings. Provisions may be made for emergency situations, see *Procedures for Managing Identified Wildlife.*

Each account was peer reviewed by a technical reviewer, operational reviewer, and IWMS reviewer. In addition, the IWMS Technical Government Working Group, IWMS stakeholder Technical Advisory Committee, and regional WHA committees reviewed accounts. In many cases other professionals and specialists, especially those involved in setting species management or recovery direction (i.e., Recovery Teams), also reviewed accounts.

Account Template

ENGLISH NAME[1]

Scientific name

Original author[2]

Species or Plant Community Information

Taxonomy

Describes current taxonomic classification. Not included in plant community accounts.

Description

Describes distinguishing features used for identification.

Distribution

Global

Describes global range.

British Columbia

Describes distribution in British Columbia.

Forest regions and districts

Describes distribution according to the Ministry of Forests administrative units (Appendix 1).

Ecoprovince and ecosections

Describes distribution using the ecoregion classification system (Appendix 2), which divides the province into hierarchically and ecologically defined units. Units are defined by climate, physiography, vegetation, and wildlife potential.

Biogeoclimatic units

Describes distribution using the biogeoclimatic ecosystem classification system (Appendix 3). Biogeoclimatic units are defined based on geographically related ecosystems that are distributed within a vegetationally inferred climatic space.

Broad ecosystem units

Describes distribution using the broad ecosystem inventory classification system (Appendix 4). A broad ecosystem unit is a permanent area of the landscape, meaningful to animal use, that supports a distinct kind of dominant vegetative cover, or distinct non-vegetated cover (such as lakes or rock outcrops). Each vegetated unit is defined as including potential (climax) vegetation and any associated successional stages (for forests and grasslands). Broad ecosystem classes have been created based on the integration of vegetation, terrain, topography, and soil characteristics. They are amalgamations of different groups of site series units, as well as site associations. Each BEU may include many distinct climax plant associations. Broad ecosystem units may not be intuitively obvious as many associated habitats may occur in a single unit (i.e., trembling aspen in the Interior Douglas-fir Forest unit).

Elevation

Elevation in metres.

---

[1] English and scientific names largely follow 2003 Resource Information Standards Committee (RISC) standards except for those subspecies without standardized English names. Non-standard English names are noted in quotation marks (e.g., "Queen Charlotte" Goshawk) in the account titles.

[2] Accounts were modified from the original drafts as part of the peer review process; IWMS legal, policy, and technical reviews; or recommendations from the IWMS Technical Advisory Committee and regional reviews.

Life History or Plant Community Characteristics

For vertebrates and invertebrates, information on the diet and foraging behaviour, reproduction, site fidelity, home range, and movements is provided. For plants, information on reproduction and dispersal is provided. For plant communities, the structural stage, natural disturbance regime, and fragility of the community are described.

Habitat

Structural stage

Lists structural stages used (Appendix 5) for forested habitats and usually only coniferous species. Structural stage depends on the age class of the ecosystem and vegetation species. For plant community accounts, the structural stage at climax condition is listed.

Important habitats and habitat features

Describes important habitats (e.g., nesting habitat) or habitat features such as wildlife trees (see Appendix 6), coarse woody debris (see Appendix 7), or canopy structure. Not included in plant community accounts. If not specifically described, age follows the definitions of the *Biodiversity Guidebook* (1995 – see http://www.for.gov.bc.ca/tasb/legsregs/fpc/fpcguide/biodiv/biotoc.htm). See Appendix 8 for scientific names of commonly referred to tree species.

Conservation and Management

Status

Describes status in British Columbia (*Red, Blue,* or *Yellow*), as determined by the Conservation Data Centre (MSRM). Provincial status is determined and reviewed biannually using the internationally accepted methods of the NatureServe. For more information, see http://wlapwww.gov.bc.ca/wld/documents/ranking.pdf. In summary, elements are ranked from 1 to 5 where 1 is critically imperilled and 5 is secure. Generally, red-listed elements are ranked 1 or 2, blue-listed elements are ranked 3, and yellow-listed elements are ranked 4 or 5.

Status in Canada, as determined by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) is also provided. COSEWIC lists species as *Extinct, Extirpated, Endangered, Threatened, Special Concern, Not at Risk,* or *Data Deficient*. For the most up-to-date lists, see http://www.cosewic.gc.ca.

NatureServe ranks are also provided for British Columbia (BC) and neighbouring jurisdictions including Alaska (AK), Yukon (YK), Northwest Territories (NWT), Alberta (AB), Washington (WA), Idaho (ID), and Montana (MT). National (N) and Global (G) ranks, which reflect an elements' status in Canada or throughout its global range, are also provided when known. This information can indicate the relative importance of conservation within British Columbia and may be used to set regional or provincial management priorities. See Appendix 9 for a description of ranking methodology and codes.

Trends

Population trends

Indicates any noted trends as well as information on abundance, number of known occurrences, and any noted increases, declines, or losses of previously occupied sites.

Habitat trends

Provides general indication of trend (i.e., unknown, likely increasing, likely decreasing, or stable).

Threats

Population threats

Describes threats to populations, such as low reproductive rate, limited dispersal ability, and disease.

Habitat threats

Describes the type of threats to a species' habitat or to a plant community, with particular emphasis on threats from forest or range management practices.

Legal Protection and Habitat Conservation

Summarizes existing legislation, policy, or guidelines that directly protect or manage elements or their habitats with emphasis on FRPA provisions and protected areas.

Identified Wildlife Provisions

Identified wildlife provisions include (1) sustainable resource management and planning recommendations, (2) wildlife habitat areas, and/or (3) general wildlife measures. There is a new provision under FRPA that enables government to set objectives for wildlife habitat areas. This provision is consistent with the shift towards more results based forest practices and enables forest tenure holders to prepare results and strategies for Forest Stewardship Plans that are consistent with objectives for wildlife habitat areas. Objectives for wildlife habitat areas have not been included in the accounts. Procedures for using this new provision are currently under development.

Sustainable resource management and planning recommendations

Recommendations for strategic or landscape level planning. Where appropriate and consistent with current land use plans and future planning processes, these recommendations may be adapted as resource management zone objectives, landscape unit objectives, or land use objectives under a sustainable resource management plan. Where recommendations are not established as legal objectives, they may provide guidance to operational plans such as forest stewardship plans.

Under the 1995 Forest Practices Code (FPC), most Identified Wildlife were managed through the establishment of wildlife habitat areas and did not require specific land use objectives to be established. Three species (Bull Trout, Fisher, and Grizzly Bear) were designated "Higher Level Plan" (HLP) species, and could be managed through the establishment of resource management zone objectives (a type of HLP under the FPC). Under the new forest legislation (FRPA), it is anticipated that, where necessary, strategic or landscape level land use objectives will be established under the *Land Act*. Nonetheless, there may be benefits from planning for the requirements of elements at the strategic and landscape level in that it may be possible to effectively plan for a greater number of species and accommodate connectivity requirements while reducing the incremental impacts to resource industries.

Strategic and landscape level objectives should be considered for species that have large home ranges, occur at low densities, have widely and sparsely distributed limiting habitats, or are sensitive to landscape level disturbances. The requirements of such species must be addressed over large areas, such as regions or watersheds, to effectively manage their populations. There are at least seven species within IWMS for which strategic level objectives should be considered: Badger, Caribou, Grizzly Bear, Marbled Murrelet, Queen Charlotte Goshawk, Spotted Owl, and Wolverine.

The requirements of Identified Wildlife may also be considered within landscape level plans. Generally, the biodiversity goal of landscape level planning is to maintain representative elements (i.e., ecosystems and stand level structural features) across the landscape to increase the probability of maintaining plant communities, species, populations, and community processes over time. However, some elements, particularly those at risk, or those associated with rarer or unique habitats, may not be adequately addressed; thus, it is important to consider more specific requirements or locations of these elements. The FRPA priorities for landscape level planning are old forest and wildlife tree retention. For many Identified Wildlife, recommendations have been made within accounts for old forest or wildlife tree retention to best meet their needs and to assist planning to meet multiple goals (i.e., IWMS, landscape or stand level biodiversity), where possible, and where these goals are compatible. These recommendations are provided for use during landscape level planning and may be developed as legal objectives.

However, in some cases, using landscape level provisions (i.e., old forest) to manage for a single species may compromise the ability to represent the full array of biodiversity elements within the landscape; thus, the implications to other biodiversity elements should always be considered.

Wildlife habitat area

Wildlife habitat areas (WHAs) are areas of limiting habitat that have been mapped and approved by the Minister of Water, Land and Air Protection. Wildlife habitat areas are designed to minimize disturbance or habitat alteration to a species' limiting habitat or to a rare plant community. In most cases, a WHA contains both a core area that is protected from habitat alteration and a management zone to minimize disturbance during critical times or to core area habitats.

Goal

Refers to the overall purpose and management of the WHA.

Feature[3]

Describes an appropriate feature that is required for establishment of a WHA (e.g., active nest area, specific number of breeding pairs or density, maternity colony, or hibernacula). Typically these will be based on limiting habitats, significant concentrations, or those habitats not addressed by coarse filter provisions (i.e., riparian management and landscape unit planning) that are currently occupied. In some cases, WHAs may be recommended for potentially or historically suitable sites for recovery or recruitment. Generally, these will be recommended or endorsed by established recovery teams to meet the requirements of the federal *Species at Risk Act*.

Size

The size of the WHA is estimated; however, these are rough estimates and are subject to site-specific considerations. Further study may determine whether these estimates are adequate to conserve the species or plant community.

Design

Describes the configuration of a WHA including recommendations for inclusion of a core area and a management zone as well as other important considerations for designing a WHA. The general design of WHAs is based on important life history characteristics such as home range size. Typically the WHA will be designed to address key management concerns, whether those are related to habitat or disturbance. Thus, in some cases the design of the WHA will be based on habitat factors and in other cases it may simply be based on distance from an important habitat feature (i.e., a nest) to minimize disturbance at that feature.

General wildlife measures

General wildlife measures (GWMs) direct forest and range practices within a WHA, specified ecosystem unit, or other spatially defined area, and have been approved by the Minister of Water, Land and Air Protection.

Goals

List of the overall objectives and desired results for management within a WHA or otherwise defined area.

Measures

General wildlife measures can address forest and range practices carried out under the Forest Practices Code (during transition) or under FRPA. The practices include road construction, road maintenance, livestock grazing, hay cutting, pesticide use, and timber harvesting. Practices have been grouped under the following headings: access, harvesting and silviculture, pesticides, range, and recreation. A GWM may limit activities partially or entirely. A GWM may apply to the core area or management zone of a WHA. When neither are specified, the GWM applies to the entire WHA. All general wildlife measures may be modified case by case by the Minister of Water, Land and Air Protection or designate. For more information, see *Procedures for Managing Identified Wildlife*.

---

[3] Not to be confused with "wildlife habitat feature."

Additional Management Considerations

Recommendations for managing an area adjacent to a WHA or for managing activities that are not regulated under the FRPA.

Information Needs

Suggested list of three main research or inventory priorities.

Cross References

List of other Identified Wildlife whose requirements and distribution may overlap with the species or plant community under consideration.

References Cited

Personal Communications

Identified Wildlife by Forest Region

See Appendix 11 for lists of Identified Wildlife by forest district.

English name	Scientific name	Coast	Southern Interior	Northern Interior
	Plants			
Scouler's Corydalis	*Corydalis scouleri*	x		
Tall Bugbane	*Cimicifuga elata*	x		
	Vertebrates			
Fish				
Vananda Creek Limnetic and Benthic Sticklebacks	*Gasterosteus* spp. 16 and 17	x		
Amphibians				
Coastal Giant Salamander	*Dicamptodon tenebrosus*	x		
Coastal Tailed Frog	*Ascaphus truei*	x	x	x
Coeur d'Alene Salamander	*Plethodon idahoensis*		x	
Great Basin Spadefoot	*Spea intermontana*		x	
Northern Leopard Frog	*Rana pipiens*	introduced	x	
Red-legged Frog	*Rana aurora*	x		
Rocky Mountain Tailed Frog	*Ascaphus montanus*		x	
Tiger Salamander	*Ambystoma tigrinum*		x	
Reptiles				
"Great Basin" Gopher Snake	*Pituophis catenifer deserticola*		x	
Birds				
Ancient Murrelet	*Synthliboramphus antiquus*	x		
Burrowing Owl	*Athene cunicularia*		x	
Flammulated Owl	*Otus flammeolus idahoensis*		x	
Great Blue Heron	*Ardea herodias fannini*	x	x	x
"Interior" Western Screech-Owl	*Otus kennicottii macfarlanei*		x	
Lewis's Woodpecker	*Melanerpes lewis*	historical	x	
Long-billed Curlew	*Numenius americanus*		x	x
Marbled Murrelet	*Brachyramphus marmoratus*	x		x
"Queen Charlotte" Goshawk	*Accipiter gentilis laingi*	x		
Sage Thrasher	*Oreoscoptes montanus*		x	
Short-eared Owl	*Asio flammeus*	x	x	x
Spotted Owl	*Strix occidentalis*	x	x	
White-headed Woodpecker	*Picoides albolarvatus*		x	
Yellow-breasted Chat	*Icteria virens*	x	x	

English name	Scientific name	Coast	Southern Interior	Northern Interior
Mammals				
Badger	*Taxidea taxus jeffersonii*	extreme east only	x	
Caribou (mountain, boreal and northern ecotypes)	*Rangifer tarandus caribou*	x	x	x
Fringed Myotis	*Myotis thysanodes*		x	
Grizzly Bear	*Ursus arctos*	x	x	x
Keen's Long-eared Myotis	*Myotis keenii*	x		
Pacific Water Shrew	*Sorex bendirii*	x		
Spotted Bat	*Euderma maculatum*		x	
Vancouver Island Marmot	*Marmota vancouverensis*	x		
Wolverine	*Gulo gulo luscus,* *Gulo gulo vancouverensis*	x	x	x

SCOULER'S CORYDALIS

Corydalis scouleri

Adapted by Sharon Hartwell and Kathy Paige[1]

Species Information

Taxonomy

Scouler's corydalis is in the *Fumariaceae* (fumitory or bleeding-heart) family. It is one of five *Corydalis* species indigenous to Canada, four of which occur in British Columbia. There are no recognized infraspecific taxa.

Description

Scouler's corydalis is a tall (0.6–1.2 m) perennial herb with thick rhizomes. Stems are upright, hollow, and may be simple or somewhat branched. The large, blue-green, deciduous leaves, usually three in number, arise from near or above the middle of the stem and are much dissected (tri- to quadripinnate). The inflorescence is a terminal or axillary raceme of 15–35 showy, rosy-pink, spurred flowers. Individual flowers are relatively small (~2.5 cm long) and bilaterally symmetrical. The fruits are pod-like capsules (10–15 mm long), containing small (4 mm) shiny black seeds. The plant is summer dormant, and foliage dies back completely after seed set. See Douglas et al. (1999, 2002) for complete description and illustrations and Pojar and MacKinnon (1994) for colour photograph.

Distribution

Global

Scouler's corydalis is limited to the Pacific Northwest, where it occurs west of the Cascades, from northwestern Oregon northward through the Olympic Peninsula to southwestern Vancouver Island (Douglas and Jamison 2000, 2001). It is frequent to common in Oregon and Washington (>100 extant populations), but rare in British Columbia (~22 extant populations).

British Columbia

In British Columbia, this species is restricted to extreme southwestern Vancouver Island. It is found in the Nitinat River valley, the northeast shore of Nitinat Lake, the Klanawa River valley, the Kissinger Lake area, immediately west of Cowichan Lake, and Heather Lake.

Forest region and district

Coast: South Island

Ecoprovinces and ecosections

COM: WIM
GED: LIM

Biogeoclimatic units

CWH: vm1

Broad ecosystem units

FR, SR

Elevation

5– ~200 m (Douglas and Jamison 2000, 2001)

Life History

Reproduction

Scouler's corydalis is a perennial, herbaceous understorey plant with thick rhizomes. It reproduces well vegetatively, generating annual stems apically from the rhizome. This vegetative growth can result in extensive single clones with numerous stems, which may cover tens of square metres (Douglas and Jamison 2001). Single leaves are produced on each stem until the plants reach sexual maturity, after 4 or more years.

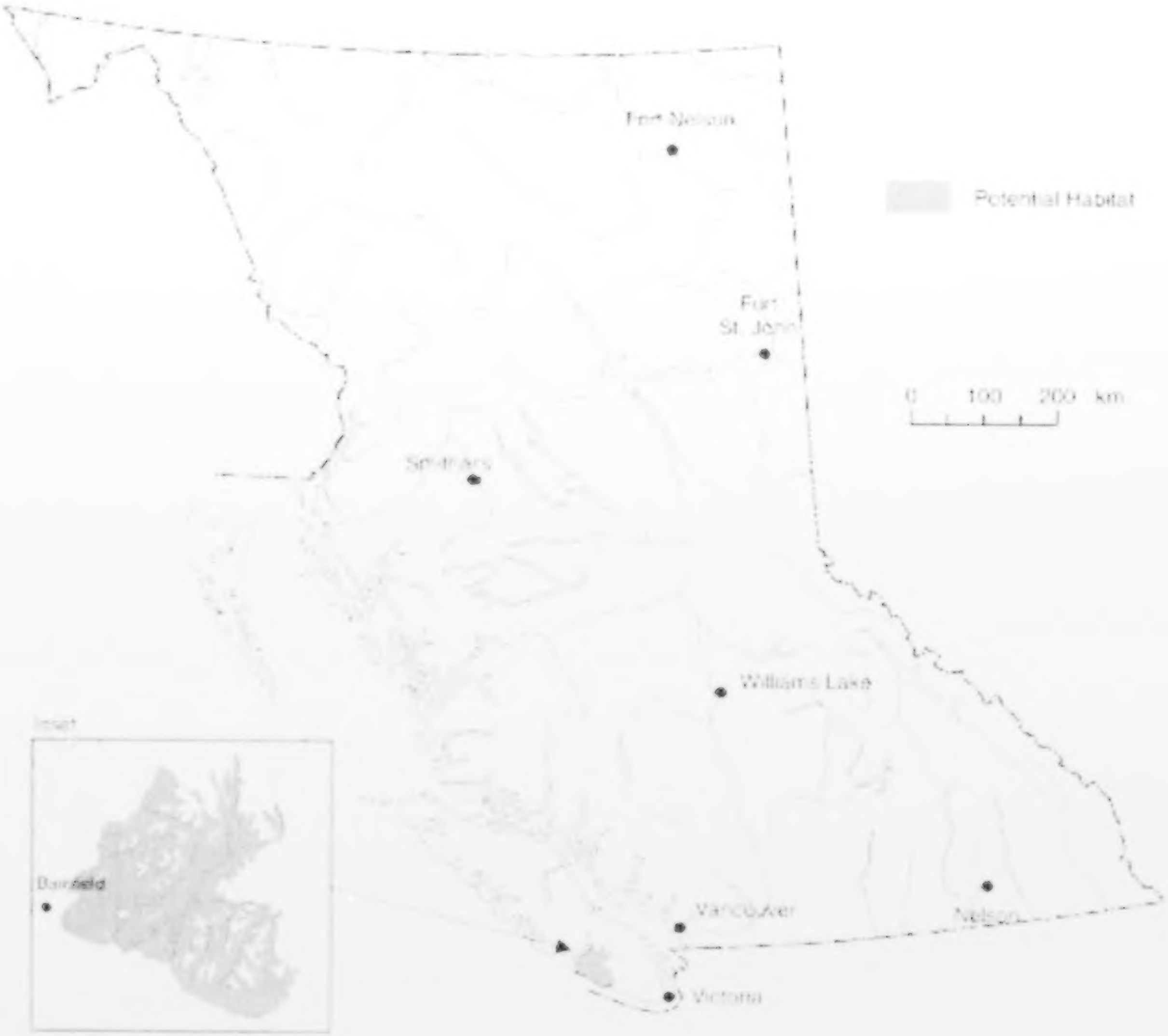
In British Columbia, flowering occurs in May and June. A raceme typically produces 15–20 flowers,

---

[1] Account largely adapted from Douglas and Jamison 2000.

Scouler's Corydalis

(Corydalis scouleri)


Fort Nelson
Potential Habitat
Fort St. John
0 100 200 km
Smithers
Williams Lake
Inset
Bamfield
Vancouver
Nelson
Victoria

Note: This map represents a broad view of the distribution of potential habitat used by this species. The map is based on several ecosystem classifications (Ecoregion and Biogeoclimatic) as well as current knowledge of the species' habitat preferences. This species may or may not occur in all areas indicated.

each with two multi-seeded carpels. There is the potential for considerable seed set, but Hitchcock et al. (1969) note that only the terminal flower of the raceme may develop, which would limit seed production. A number of pollinators visit the species. Self-fertilization is also a possibility (Ownbey 1947), but Ryberg's observations of cultivated specimens lead him to speculate that Scouler's corydalis is probably self-sterile (1960).

Dispersal

The ripe seed capsule explodes elastically when disturbed, spreading seeds a considerable distance. Seeds are also typically dispersed by ants (D. Fraser, pers. comm.); however, the seeds are also short lived and readily dry out. Periodic flooding may facilitate dispersal of both rhizome fragments and seeds (Douglas and Jamison 2000, 2001).

Habitat

Structural stage

5: young forest
6: mature forest
7: old forest

Important habitats and habitat features

In British Columbia, Scouler's corydalis grows in cool, moist, shady habitats adjacent to watercourses, which vary in size from moderately large rivers (Nitinat and Klanawa) to small tributary streams (Jasper Creek, Vernon Creek) and roadside ditches draining into streams (Old Nitinat Campsite). The fine silts and sediments of floodplains and alluvial flats and river benches are prime habitat, but the plant also grows where silty soil is combined with coarser floodplain material or river-smoothed rocks on stream banks, river terraces, islands, and bottomlands. Known sites occur on slopes ranging from 0 to 45%. Aspects include west, southwest, and north to northeast.

The preferred cool, moist, and moderately shady habitat is usually found in deciduous or mixed forests. Occurs in young and older dominant red alder (*Alnus rubra*) stands, but is also found in mixed conifer stands with mature big-leaf maple (*Acer macrophyllum*) and Sitka spruce (*Picea sitchensis*), as well as red alder, western redcedar (*Thuja plicata*), and western hemlock (*Tsuga heterophylla*). Understorey associates include western swordfern (*Polystichum munitum*), salmonberry (*Rubus spectabilis*), red elderberry (*Sambucus racemosa*), devil's-club (*Oplopanax horridus*), palmate-leaved coltsfoot (*Petasites palmatus*), and stink currant (*Ribes bracteosum*) (Douglas and Jamison 2000, 2001). These plant communities are typically found in areas of high precipitation, with a nitrogen-rich moder and mull humus (Douglas and Jamison 2000, 2001).

At least two of the Nitinat River populations occur in older forest (one in a *Tsuga heterophylla/Acer macrophyllum* stand, and one in a *Picea sitchensis* stand). The remaining sites range from young to mature forest.

Although all of the known populations in British Columbia occur adjacent to watercourses, Diaz and Mellen (1996) classify Scouler's corydalis as a facultative, rather than obligate, wetland species. The plant can be cultivated in shady or woodland situations and is grown by gardeners in Europe (Ownbey 1947) and the Pacific Northwest, where it is sold by nurseries specializing in native plants.

Conservation and Management

Status

Scouler's corydalis is on the provincial *Blue List* in British Columbia. It is designated as *Threatened* in Canada (COSEWIC 2002).

Summary of ABI status in BC and adjacent jurisdictions (NatureServe Explorer 2002)

BC	WA	OR	Canada	Global
S3	S?	S?	N3	G4

Trends

Population trends

Population trends are not possible to determine due to the lack of information for the few existing historical records. The 22 extant populations in British Columbia are restricted to two major watersheds on southwestern Vancouver Island (Klanawa, Nitinat, and immediately east of the Nitinat near Cowichan Lake). These populations range in size from one stem to 100 000 stems growing over a 6-ha area.

Habitat trends

Not known. Scouler's corydalis occurs on southwest Vancouver Island, an extensively logged area with a widespread network of logging roads providing widespread access. In addition, southwest Vancouver Island is used extensively for recreational activities.

Recreational activity has also had an impact on the riparian habitat of southwest Vancouver Island. Forestry recreation sites tend to be situated on lakeshores and riverbanks, and there are several along the Nitinat River, including Nitinat Provincial Park. Nitinat Lake is a popular windsurfing destination, and the campsite at the mouth of the Caycuse River receives heavy use. A moderate-sized population of Scouler's corydalis (ca. 500 stems) exists close to this site.

Threats

Population threats

Scouler's corydalis propagates very successfully by rhizomatous growth, but appears to have low sexual reproductive success and possibly has limited seed dispersal (Douglas and Jamison 2000, 2001; D. Fraser pers. comm.). These characteristics, combined with the limited number of populations in the province, may well have resulted in a lack of genetic heterogeneity. If this is true, the long-term survival of the species in British Columbia could be at risk due to factors such as disease.

Habitat threats

Forest management practices including road building and maintenance, may be a potential threat to habitat for Scouler's corydalis. Logging occurring too close to rivers and streams may damage individuals, alter suitable habitat by removing shade cover, or cause downstream erosion or flooding which could result in alteration or loss of habitat. Road maintenance and stream crossing developments may have an impact. However, new road and bridge construction and forest harvesting will be limited in known sites of Scouler's corydalis (Beese, pers. comm.; Ferguson pers. comm.)

Recreational activity may also be a threat. Along the Nitinat River, logging roads and their associated bridges provide direct access to more than half the known populations of Scouler's corydalis. The summer dormancy of the species makes it difficult to detect. Repetitive or continuous recreational activity such as camping in the same site where Scouler's corydalis is found may potentially affect populations.

Large scale or severe flooding of the Nitinat River could result in loss or alteration of habitat, although it might also assist in dispersing seeds and rhizomes. An examination of the historic patterns of flooding in these watersheds could yield insight to population distribution and density. Where there are small populations, natural flooding and resultant erosion may threaten their continued existence.

Forest succession will lead to changes in forest structure which will eventually shade out the corydalis.

Legal Protection and Habitat Conservation

There is currently no legislation that specifically protects Scouler's corydalis in British Columbia. One population occurs within an ecological reserve and is protected from human disturbance.

The riparian management recommendations under the results based code will be the most important component in protecting this species, because the majority of known populations are adjacent to rivers and creeks of significant size. A number of populations are on private land (e.g., Caycuse River sites on the Nitinat downstream from the fish hatchery, and sites west of Cowichan Lake, near Kissinger Lake).

Identified Wildlife Provisions

Wildlife habitat area

Goal

Maintain populations and provide adequate habitat for populations to persist.

Feature

Establish WHAs at known populations.

Size

WHAs for this species will typically be <10 ha. The WHA size will ultimately depend on the extent of the individual population and suitable habitat as well as surrounding conditions, which will determine the size of the management zone.

Design

The WHA should include a core area and management zone. The core area should be defined by the perimeter of the population. Most of the known populations have been mapped. Most are <1 ha although one population occurs over several hectares. The management zone will normally be approximately 50 m but may extend up to 250 m depending on site-specific characteristics, but should be large enough to preserve the ambient conditions and be windfirm. In some cases a wider management zone may be required on the upslope side of the population to maintain hydrological conditions.

General wildlife measures

Goals

1. Prevent direct mortality from road or stream crossing construction or maintenance activities.
2. Maintain core area as suitable habitat to allow population to persist.
3. Maintain microclimatic conditions (i.e., light conditions, soil moisture).
4. Avoid creating large canopy gaps.
5. Maintain hydrological conditions of core area.
6. Maintain important habitat features (e.g., dominant overstorey tree species, such as *Alnus rubra, Acer macrophyllum,* and *Picea sitchensis*).

Measures

Access

- Do not construct access structures (roads, trails, or stream crossings) in the core area.
- Avoid developing access structures in the management zone, particularly upslope of the core area.
- Where roads are determined to be necessary or already exist within WHA, ensure road maintenance activities do not damage or kill plants and use methods to prevent the spread of invasive species.

Harvesting and silviculture

- Do not harvest within core area except for treatments aimed at maintaining or improving stand characteristics for Scouler's corydalis.
- Use partial harvesting systems in the management zone that maintain ~60% basal stem area. Remove 40% basal steam area in small openings.
- Do not salvage unless it can be done without disturbing important structural elements (e.g., dominant overstorey trees).

Pesticides

- Do not use pesticides.

Recreation

- Do not develop recreational trails, facilities, or structures within the core area.

Information Needs

1. Baseline biological and ecological information for British Columbia.
2. Genetic research on Scouler's corydalis populations in British Columbia (e.g., genetic diversity, heterogeneity).
3. Long-term response of populations of Scouler's corydalis to human and natural occurrences to different activities.

Cross References

Marbled Murrelet, "Queen Charlotte" Goshawk, "Vancouver Island" Common Water Shrew

References Cited

Committee on the Status of Endangered Wildlife in Canada (COSEWIC). 2002. Canadian species at risk. Available from: http://www.speciesatrisk.gc.ca

Diaz, N.M. and T.K. Mellen. 1996. Riparian ecological types, Gifford Pinchot and Mt. Hood National Forests, Columbia River Gorge National Scenic Area. USDA For. Serv., Pac. Northwest Region. R6-NR-TP-10-96. 203 p. + appendices.

Douglas, G.W. and J.A. Jamison. 2001. Status of Scouler's Corydalis, *Corydalis scouleri* (Fumariaceae) in Canada. Can. Field-Nat. 115(3):455–459.

______. 2000. Status report on Scouler's Corydalis (*Corydalis scouleri*). Report prepared for the Committee on the Status of Endangered Wildlife in Canada, Ottawa, Ont. 18 p. Unpubl.

Douglas, G.W., D. Meidinger, and J.L. Penny. 2002. Rare native vascular plants of British Columbia. B.C. Min. Sustainable Resour. Manage., B.C. Min. For., and B.C. Min. Water, Land and Air Prot., Victoria, B.C. 358 p.

Douglas, G.W., D. Meidinger, and J. Pojar. 1999. Illustrated flora of British Columbia. Vol. 3: Dicotyledons (Diapensiaceae through Onagraceae). B.C. Min. Environ., Lands and Parks and B.C. Min. For., Victoria, B.C. 423 p.

NatureServe Explorer. 2002. An online encyclopedia of life [Web application]. Version 1.6. Arlington, Va. Available from: http://www.natureserve.org/explorer

Ownbey, G.B. 1947. Monograph of the North American species of *Corydalis*. Ann. Missouri Bot. Garden 34:187–259.

Pojar, J. and A. MacKinnon. 1994. Plants of coastal British Columbia. B.C. Min. For. and Lone Pine Press, Vancouver, B.C. 525 p.

Ryberg, M. 1960. A morphological study of the Fumariaceae and the taxonomic significance of the characters examined. Acta Horti Bergiani 19(4):121–248.

Personal Communications

Beese, W.J. 2003. Weyerhaeuser Company. Nanaimo, B.C.

Fraser, D. 2003. Min. Water, Land and Air Protection, Biodiversity Br., Victoria, B.C.

Ferguson, B. 2003. TimberWest Forest Corp. Nanaimo, B.C.

TALL BUGBANE

Cimicifuga elata

Original prepared by Jenifer L. Penny

Species Information

Taxonomy

Tall bugbane is in the Ranunculaceae (buttercup) family. It is one of six *Cimicifuga* species in North America. There are no recognized infraspecific taxa. The taxonomy of the *Cimicifuga* genus is currently under review and may be included under the genu *Actaea*, in which case tall bugbane would be referred to as *Actaea elata*.

Description

Perennial, large-leafed understorey plant that stands 1–2 m tall. Stems are branched above and leaves are bi-ternate with 9–17, cordate to ovate, often palmate leaflets, which are usually three-lobed. This species has a dark, tuberous, horizontal rhizome. The inflorescence is a simple to compound raceme with 50–900 small, white, closely crowded flowers. Individual flowers are radially symmetrical and apetalous, and sepals are white or pinkish, falling off at once. Fruits are follicles, 9–12 mm long, subsessile, appearing singly in the upper flowers, but in two's, and rarely, three's on the lower raceme. Follicles each contain approximately 10 red to purple-brown seeds.

Distribution

Global

Occurs from extreme southwestern British Columbia south to southwestern Oregon. It is rare throughout its entire range in the Pacific Northwest, but is particularly rare in British Columbia.

British Columbia

Only known from 10 sites near Chilliwack, British Columbia.

Forest region and district

Coast: Chilliwack

Ecoprovince and ecosection

COM: EPR, NWC

Biogeoclimatic units

CWH: dm, ms1

Broad ecosystem units

CD, FR

Elevation

300–1300 m

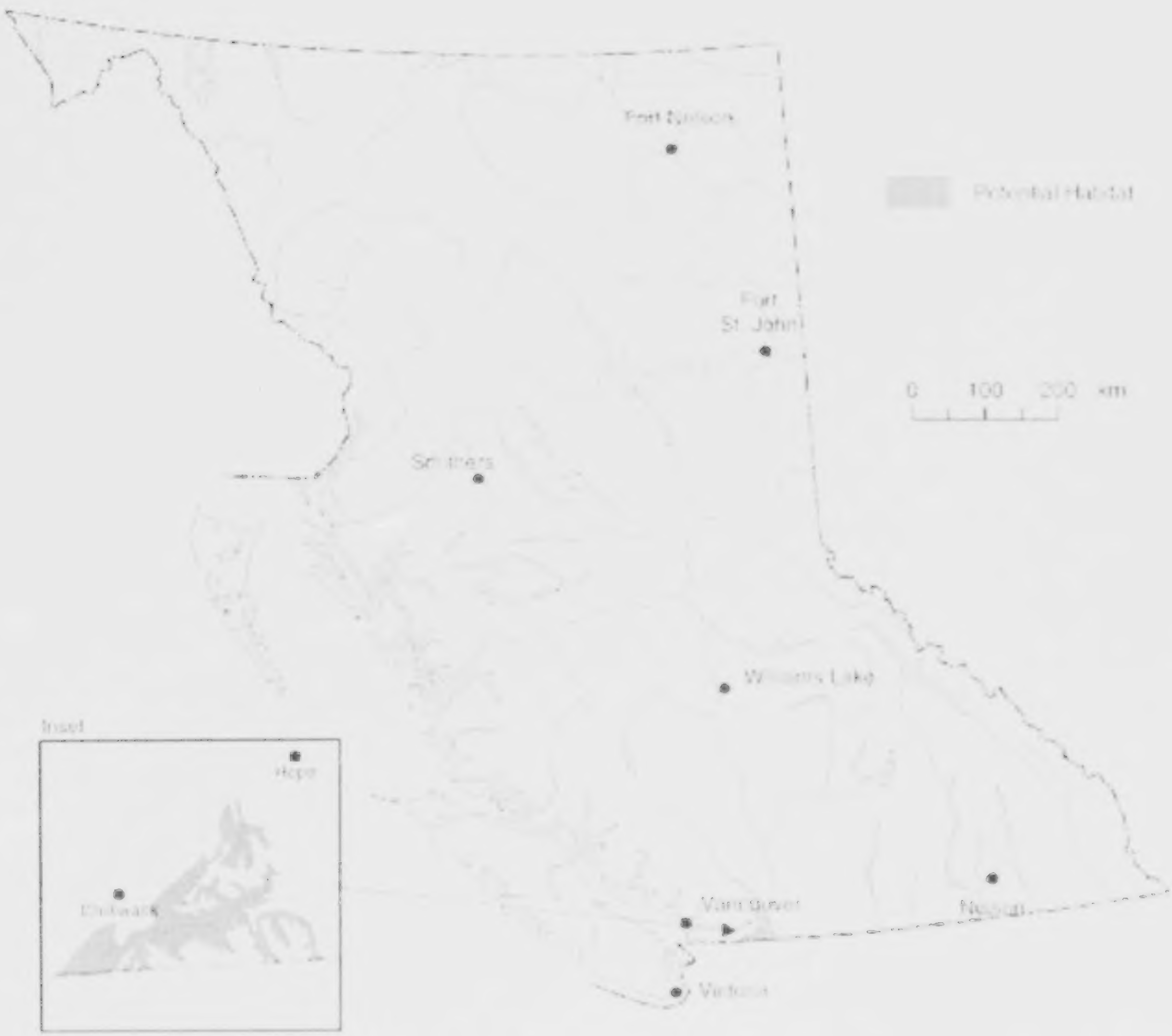
Life History

Reproduction

Tall bugbane is a herbaceous long-lived perennial understorey plant. Young plants emerge in the spring, produce buds in late spring, and flower mid-June to August. In experiments, Kaye and Kirkland (1994) showed that seeds required cold-stratification for germination and that percentage germination was low. In growth experiments on tall bugbane using ample light, plants grew to reproductive size in 3 years (USDA For. Serv., USDI BLM, and U.S. Army Corps of Engineers 1996). Under less ideal conditions, time to reproductive size could be up to 6 years.

Tall Bugbane

(Cimicifuga elata)


Fort Nelson
Potential Habitat
Fort St. John
0 100 200 km
Smithers
Williams Lake
Inset
Hope
Chilliwack
Vancouver
Nelson
Victoria

Note: This map represents a broad view of the distribution of potential habitat used by this species. The map is based on several ecosystem classifications (Ecoregion and Biogeoclimatic) as well as current knowledge of the species' habitat preferences. This species may or may not occur in all areas indicated.

Dispersal

Seeds are heavy, have no special dispersal mechanism, and are dispersed within a few metres of the parent plant (Kaye and Kirkland 1994; Wentworth 1996).

Habitat

Structural stages

1–3: non-vegetated to tall shrub (<15 yr)
4–6: pole/sapling to mature forest (70–150 yr)

Important habitats and habitat features

In British Columbia, this species grows in shady, moist, mature (70–150 yr) western redcedar forest, commonly in *Thuja plicata-Polystichum munitum-Achlys triphylla* communities. This species is nearly always associated with bigleaf maple (*Acer macrophyllum*). In Washington and Oregon, it generally requires a hardwood component in the canopy, subsurface moisture (often provided by creeks or rivers), and occurs on northerly slopes (Kaye and Kirkland 1994). In British Columbia, it has been found on road-cuts, in clearcuts, and in mature forests with strong deciduous components. Plants have also been observed in deciduous stands. Kaye and Kirkland (1999) describe tall bugbane as "light flexible" rather than old growth dependent and shade restricted (Collins et al. 1985).

The deciduous component of mixed forest is important in maintaining optimal light conditions for this species. Deciduous trees species that occur with tall bugbane include bigleaf maple (*Acer macrophyllum*), vine maple (*A. circinatum*), and Douglas maple (*A. glabrum* var. *douglasii*). Bigleaf maple is the most important as it occupies the forest canopy, increasing forest floor light during the spring. Natural canopy gaps provide the opportunity for flowering and establishment of progeny.

In British Columbia, known sites occur on 15–35° slopes with north, southwest, and south aspects. In southern populations (Oregon and Washington), this species nearly always occurs on northern slopes from east to west aspects. This may be an important distinction between northern and southern populations but needs to be confirmed.

Conservation and Management

Status

The tall bugbane is on the provincial *Red List* in British Columbia. It is considered *Endangered* in Canada (COSEWIC 2002).

Summary of ABI status in BC and adjacent jurisdictions (NatureServe Explorer 2002)

BC	WA	OR	Canada	Global
S1	S2	S2	N2	G2

Trends

Population trends

No long-term studies on population trends have ever been undertaken in British Columbia. However, two of the 10 populations in the Chilliwack River Valley (one of which has not been observed since 1957) appear to have been reduced due to extensive logging at the sites. One population was lost due to the development of a helicopter landing pad. All of the populations are small and sporadically distributed (Penny and Douglas 1999). The southern populations in Oregon tended to be larger (i.e., several hundred to several thousand plants) and have larger and more reproductive plants than northern populations (Kaye 2000). In British Columbia, the largest population is 63 plants (Penny and Douglas 1999).

Habitat trends

The forests of the Pacific Northwest have become increasingly fragmented due to past logging practices. A high proportion of the mature to old forest in the Chilliwack forest district have been converted to young forest, disturbing natural conditions for tall bugbane. Initially, plants respond favourably after logging (clearcuts), but there are several risks to its continued persistence following the initial disturbance.

Threats

Population threats

Populations are small, and sporadically distributed over the landscape. Small populations are susceptible to low genetic diversity and imminent extirpation. In addition, tall bugbane is relatively much less attractive to pollinators than other flowering plants, and therefore, receives less visits, and has less reproductive success. Further limiting this species is the lack of a specialized seed dispersal mechanism. Due to this species' reproductive limitations, colonization into new sites or recolonization into former sites may be limited.

Habitat threats

The main threats to this species are forest harvesting, road construction, and lack of reproductive potential and recruitment (Penny and Douglas 1999; Kaye 2000). This species has been found in both mature forest and clearcuts, but it likely naturally grows in mature to old forest with canopy gaps (Kaye and Kirkland 1994). Clearcuts can provide the necessary conditions for seedling establishment, but the early stages of forest growth may overcome the plants due to intense competition. Thus, although tall bugbane responds favourably to removal of the forest canopy (Kaye and Kirkland 1999), the longer term impacts are unknown.

Plants may also grow on road cuts due to the favourable conditions for seedling germination but these plants may be threatened by roadside maintenance activities such as mowing and spraying which could kill adult plants, reduce seed production, or cause mortality of new seedlings (Kaye and Kirkland 1999).

Tall bugbane has reproductive limitations that make colonization into new sites difficult. It is relatively much less attractive to pollinators than other flowering plants, and lacks any effective seed dispersal mechanism.

Other potential threats include competition with invasive species.

Legal Protection and Habitat Conservation

There is currently no legislation that specifically protects tall bugbane in British Columbia. None of the populations are found in protected areas. However, one population on Vedder Mountain is partially protected within a small wildlife tree retention area and a visual landscape reserve.

Old growth management areas are unlikely to be located in the appropriate locations to meet the needs of this species. Riparian reserves will likewise not be important in protecting this species. This species does not typically grow along watercourses.

Identified Wildlife Provisions

Wildlife habitat area

Goal

Maintain the population and provide adequate space for population to persist as well as maintain a seed source for colonization or recolonization into nearby suitable habitat.

Feature

Establish WHAs at known or historical populations. A population is considered to be a cluster of individuals that are likely interbreeding, that is, they are not separated by any barrier that would restrict reproduction. Large distances could be a barrier, so populations are generally defined by polygons with a radius of no more than 500 m.

Size

Typically between 20 and 40 ha but will depend on site-specific conditions such as size of the population and area covered by population.

Design

The WHA should include a core area and a management zone. The core area is defined using the perimeter of the population plus a 30–50 m band surrounding the population. The management zone should be 150–200 m depending on site-specific characteristics but should be large enough to preserve the ambient conditions and be windfirm. In some cases a wider management zone may be required on the upslope side of the population to maintain hydrological conditions.

General wildlife measure

Goals

1. Prevent direct mortality from road construction or maintenance activities.
2. Maintain core area as suitable habitat to allow population stability or growth.
3. Maintain microclimatic conditions (i.e., light conditions, soil moisture).
4. Minimize introduction and spread of invasive species.
5. Maintain the diverse stand structural components (e.g., Acer spp., canopy gaps).
6. Maintain an open canopy.
7. Maintain hydrological characteristics of core area.

Measures

Access

- Do not construct roads, trails, or stream crossings, particularly upslope of the population.
- Rehabilitate temporary access structures where possible.
- Where roads are determined to be necessary or already exist within WHA, ensure road maintenance practices do not damage or kill plants (i.e., do not mow plants) and use methods to prevent spread of invasive species (i.e, use control measures and seed with native species).

Harvesting and silviculture

- Do not harvest within core area except for treatments aimed at maintaining or improving stand characteristics for this species.
- Use partial harvesting systems in the management zone that maintain 60% basal stem area. Remove 40% basal stem area in small openings with a minimum of only a few crowns per gap.
- Retain *Acer* species, particularly *Acer macrophyllum*. Retain at least 20–30% from inventory distribution.
- Do not salvage unless it can be done without disturbing important structural elements (e.g., *Acer* species).
- Include deciduous species specifically *Acer* species, in the Free Growing standards.
- Use stand tending activities to promote canopy gaps around identified individuals of tall bugbane.

Pesticides

- Do not use pesticides.

Recreation

- Do not develop recreational trails, facilities, or structures within core area.

Additional Management Considerations

Avoid seeding with non-native species within the stand in which the WHA is found.

Avoid foliar or broadcast spraying of herbicides within the stand in which the WHA is found.

Promote persistence of deciduous species, in particular *Acer*, during stand tending activities.

Information Needs

1. Baseline biological and ecological data on tall bugbane in British Columbia.
2. Response of populations of tall bugbane to different logging treatments (i.e., population structure, inflorescence production, and average reproductive plant size) following treatments (done on more southerly populations, but not on Canadian populations).
3. Long-term viability of tall bugbane in managed forests in British Columbia.

Cross References

Coastal Tailed Frog, Marbled Murrelet, Pacific Water Shrew

References Cited

Collins, B.S., K.P. Dunne, and S.T.A. Pickett. 1985. Responses of forest herbs to canopy gaps. *In* The ecology of natural disturbance and patch dynamics. S.T.A. Pickett and P.S. White (editors). Academic Press, Inc., San Diego, Calif., pp. 217–234.

Committee on the Status of Endangered Wildlife in Canada (COSEWIC). 2002. Canadian Species at Risk. www.speciesatrisk.gc.ca

Kaye, T. 2000. Population dynamics of tall bugbane and effects of forest management. USDI Bur. Land Manage., U.S. Dep. Agric. For. Serv., and Oreg. Dep. Agric., Plant Conserv. Biol. Program. 29 p.

Kaye, T. and M. Kirkland. 1994. *Cimicifuga elata:* status, habitat analysis, monitoring, inventory, and effects of timber management. Report prepared for the Oreg. Dep. Agric., Salem, Oreg. Unpubl.

_____. 1999. Effects of timber harvest on *Cimicifuga elata*, a rare plant of western forests. Northwest Sci. 73(3):159–167.

NatureServe Explorer. 2002. An online encyclopaedia of life. Version 1.6. NatureServe. Arlington, VA. Available at http://www.natureserve.org/explorer/

Penny, J.L. and G.W. Douglas. 1999. Status of the Tall Bugbane, *Cimicifuga elata* (Ranunculaceae) in Canada. Can. Field-Nat. 113(3):461–465.

Wentworth, J. 1996. Report on the status in Washington of *Cimicifuga elata* Nutt. Report prepared for the Wash. Nat. Heritage Program, Olympia, Wash. Unpubl. 44 p.

VANANDA CREEK LIMNETIC STICKLEBACK

Gasterosteus species 16

VANANDA CREEK BENTHIC STICKLEBACK

Gasterosteus species 17

Original prepared by Paul Wood,
Joslyn Oosenbrug, and Sarah Young

Species Information

Taxonomy

The two Vananda Creek stickleback species occur *in situ* as a pair of closely-related species and therefore are described together in this account. They are known as the Vananda Creek Limnetic Stickleback (*Gasterosteus* species 16) and the Vananda Creek Benthic Stickleback (*Gasterosteus* species 17).[1]

The threespine sticklebacks (*Gasterosteus* spp.) are found only in the northern hemisphere. They are a species complex consisting of numerous reproductively isolated populations distributed along the coastal areas of the north Atlantic and north Pacific oceans, both in marine and adjacent freshwater environments (Bell and Foster 1994a). The amount of phenotypic variation among freshwater populations, and their rapid rate of evolution from marine forms have offered evolutionary biologists tremendous insight into the mechanisms of adaptive radiation and speciation. The recently evolved (post-Pleistocene) populations of North American freshwater sticklebacks have been of particular interest. Among these populations, Lavin and McPhail (1985) have documented a tendency: in large, deep lakes, limnetic plankton-feeding forms have evolved; and, in small, shallow lakes, littoral benthic-foraging forms have evolved (see also Hatfield and Schluter 1999).

However, among all stickleback populations in the world, only in six small lakes in British Columbia have sympatric limnetic and benthic forms evolved (McPhail 1994, p. 418): the Enos Lake Limnetic and Benthic sticklebacks (McPhail 1984, 1989); the Paxton Lake Limnetic and Benthic sticklebacks (McPhail 1992); the Hadley Lake Limnetic and Benthic sticklebacks (McPhail 1994); and, in Emily, Priest, and Spectacle lakes on Van Anda Creek, what are now known as the Vananda Creek Limnetic and Benthic sticklebacks (McPhail 1994; Hatfield 2001b).

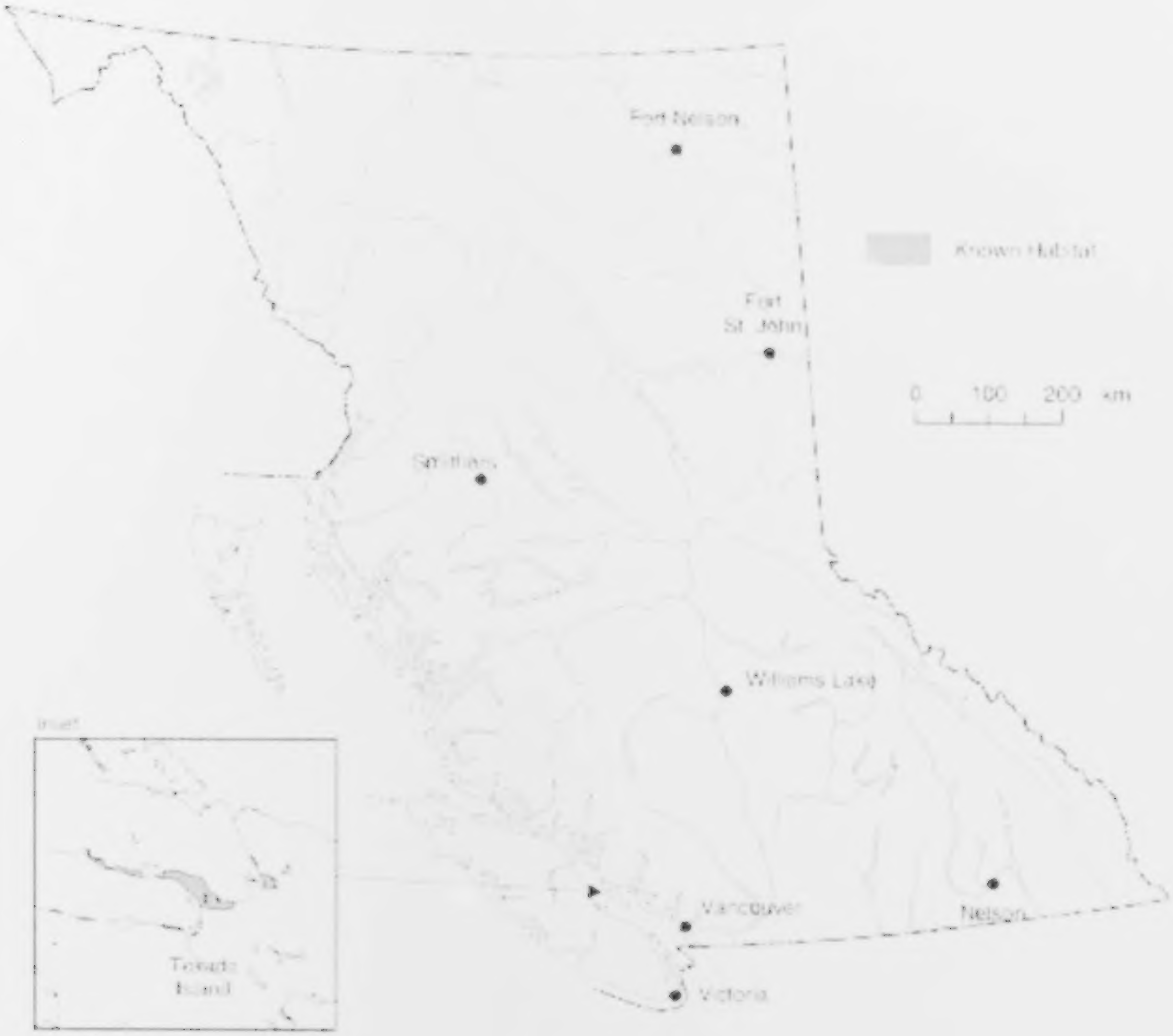
Even more surprising than the phenomenon of sympatric, reproductively isolated species is the realization that these four pairs of species evolved in parallel (Rundle et al. 2000; Schluter 2000). A recent review of the concept of evolutionarily significant units suggests that some gene flow between or among reproductively isolated populations within species complexes may be necessary for long-term viability (Crandall et al. 2000). However, there is little question among stickleback researchers that the pairs of sticklebacks in British Columbia are not simply evolutionary significant units (Foster et al. 2003), but are biological species in themselves (Hatfield 2001b, p. 586). They are also among the world's best examples of rapid adaptive radiation and parallel evolution (Bell and Foster 2003). Not surprisingly, therefore, these pairs of sticklebacks are the subject of intense interest and research among evolutionary biologists (cf. Schluter and McPhail

---

[1] The two species described in this account were named after Van Anda Creek. Until recently, the spelling for this creek was "Vananda" (i.e., one word) as was the town of the same name. The spellings of the town and the creek have now been changed to "Van Anda" (i.e., two words). The common names for the two stickleback species, however, still use the one-word spelling: Vananda.

Vananda Creek Limnetic and Benthic Sticklebacks

(Gasterosteus sp. 16 and 17)


Fort Nelson
Known Habitat
Fort St. John
0 100 200 km
Smithers
Williams Lake
Inset
Texada Island
Vancouver
Nelson
Victoria

Note: This map represents a broad view of the distribution of habitat used by this species. The map is based on current knowledge of the species' distribution. This species may or may not occur in all areas indicated.

1992; Bell and Foster 1994b; Nagel and Schluter 1998; Rundle et al. 2000; Kraak et al. 2001).

The Hadley Lake pair is now extinct (Hatfield 2001a). This species account describes the Vananda Creek pair of sticklebacks.

Description

McPhail (1984, 1989, 1992, 1994), Hatfield (2001b), and Hatfield and Ptolemy (2001) have described the three remaining pairs of stickleback species in British Columbia. In general terms, they are small, silvery-green to black fish, <70 mm in length, with a laterally compressed body form. They have calcified lateral plates and retractable dorsal and pelvic spines.

The limnetic sticklebacks are smaller but more thoroughly armoured than the benthic sticklebacks. They are pelagic, zooplankton-feeding fish, and their relatively high numbers of gill rakers are presumed to be a plankton-feeding adaptation (Bentzen and McPhail 1984).

By contrast, the benthic sticklebacks are bottom-foraging fish with a larger and relatively stockier or chunky body form. They have conspicuously wide, short jaws, which are also presumed to be a feeding adaptation (Bentzen and McPhail 1984).

There is genetic evidence that the Enos Lake, Paxton Lake, and Vananda Creek pairs represent separate gene pools (McPhail 1984, 1992; Taylor and McPhail 1999).

Distribution

Global

The Vananda Creek Stickleback species occur only on Texada Island, British Columbia.

British Columbia

In British Columbia, these two species occur only in Emily, Priest, and Spectacle lakes in the Van Anda Creek watershed on Texada Island. There is no evidence to suggest that any sticklebacks in the fourth lake in the Van Anda Creek watershed, Kirk Lake, have evolved into a species pair.

Forest region and district

Coast: Sunshine Coast

Ecoprovince and ecosection

GED: SOG

Biogeoclimatic unit

CWH: xm

Elevation

The surface elevation of Emily Lake is approximately 40 m, while that of both Priest and Spectacle lakes is approximately 80 m (Hatfield 1998).

Life History

Diet and foraging behaviour

The Vananda Creek limnetics form loose schools in the open-water portions of the lakes where they feed on zooplankton (e.g., copepods and insect larvae) (Hatfield 2001b).

Vananda Creek benthics forage near the shallower lake edges, or in somewhat deeper water, for prey such as clams, dragonfly nymphs, and snails. As benthics grow larger, they pursue larger prey (Hatfield 2001b).

Juvenile sticklebacks remain in the littoral regions of the lakes where they pick invertebrates off vegetation. While nesting in the littoral zone, the males of both species—limnetics and benthics—often prey on benthos (Hatfield 2001b).

Reproduction

The Vananda Creek limnetics mature after 1 year and rarely live beyond 2 years; whereas the benthics seem to mature older and live longer, possibly as long as seven years. Breeding season is from April to June in B.C. populations, and is initiated when the males develop reddish throats and fore-bellies, and construct tubular nests (Foster 1994). Although courtship is a complex ritual, mate selection by the females is largely influenced by visual cues, particularly the red colouration on the males (Bakker and Rowland 1995; Baube et al. 1995). Immediately after a female lays her eggs in a nest, the male fertilizes them.

Males may mate with several females over a 1–4 day period before switching to a parental-care phase. In this phase, the male protects the eggs and fry from predators and also fans them, thereby providing them with sufficient oxygen (Foster 1994).

Females, by contrast, do not tend the young and continue to produce multiple clutches. Typical fecundity for a limnetic female is between 30 and 40 eggs per clutch or approximately 50 or 60 eggs for a really large female. Limnetic females produce several clutches a year in quick succession if food availability is high. Benthic females often carry more than 150 eggs and can carry up to 200 eggs. They produce only one or two clutches a season, regardless of food availability.

Home range/Site fidelity

The two species are restricted to the three small lakes—Emily, Priest, and Spectacle—on the Van Anda Creek mainstem. The two species remain in the lacustrine environment year round.

The males will defend a territory during the nest construction, mating, and parental care phases of the breeding process. The size of the defended territory is usually related to the size of the individual male.

An individual male may repeat the cycle of phases several times during a single breeding season. As a nest is generally severely damaged during the release of the fry, a male repeating the cycle will of necessity build a new nest (T. Hatfield, pers. comm.).

Movement and dispersal

When sufficiently large, the juveniles disperse from the littoral zones along the shorelines to open-water (limnetics) or deeper-water (benthics) portions of the lakes. For the limnetics, dispersal occurs towards late summer, when they become larger and swift enough to escape predators and their spines are of sufficient size to act as a deterrent (B.C. MELP 1999). This distance can be a matter of a few tens of metres, or perhaps upwards of a few hundred metres. Benthics continue to forage along the shallow margins of the lake for larger and larger prey as they grow, then move to deeper water to overwinter.

Habitat

Important habitats and habitat features

Breeding

From April to June, both species move from the more open-water or deeper-water portions of the lakes to the shallower, vegetated littoral zones to breed. Males of both species construct their nests in these shallow, vegetated littoral zones (McPhail 1994; Vamosi and Schluter 1999). The specific habitats in which limnetics and benthics choose to build their nests differ slightly (McPhail 1994). Hatfield (2001b) has noted that limnetic males choose slightly more open nesting sites (i.e., those sites with less aquatic vegetation) on gravel or rock substrates, or on submerged logs, and at water depths of no more than 1 m. Benthic males, by contrast, choose sites with aquatic vegetation, and in slightly deeper water, but rarely deeper than 2 m. These breeding microhabitats are highly sensitive, as discussed under "Threats" below.

Foraging

As the names of the two species imply, one feeds in the open-water, limnetic portions of the lakes near the surface, while the other feeds along the shallow margins of the lake either on the bottom (benthos) or by picking invertebrates off plants. It is precisely this difference in behaviour that is believed to have led to the reproductive isolation of these species, despite the fact that they inhabit the same lakes (Schluter 1993, 1995).

Conservation and Management

Status

The Vananda Creek Limnetic and the Vananda Creek Benthic Stickleback are on the provincial *Red List* in British Columbia. In Canada, both species are designated as *Endangered* (COSEWIC 2002).

Summary of ABI status in BC and adjacent jurisdictions (NatureServe Explorer 2002)

BC	Canada	Global
S1	N1	G1

Trends

Population trends

Total population sizes and trends are unknown. However, Hatfield (2001b) reported that the populations were abundant in all three lakes.

Habitat trends

The aquatic habitats of Priest, Spectacle, and possibly Emily lakes have been impacted for some time by the dam located at the outlet of Priest Lake (Priest and Spectacle by the impoundment and the regulation of water levels; Emily by any regulation of the flow regime downstream of the dam). Records indicate that the current dam is a concrete structure, 1.8 m in height. A review of the water licence data suggests that major changes to the associated waterworks occurred around 1956, and a significant change in the storage capacity of the reservoir occurred around 1973 (J.G. Norris, pers. comm.).

The aquatic habitats of the three lakes can be impacted by sedimentation derived from erosion events on the lands within the watershed surrounding the lakes. The lands in the Van Anda Creek drainage have a long history of disturbances including forest harvesting. The authors are not aware of any references that document the exact timing, extent, or type of logging in this drainage in the past. While it was a not uncommon practice in the late 1800's to log with what are now known as "high-grading" practices (i.e., removing only the biggest trees), "a majority of stands are second growth…with no mention of vets in the polygon label" on the forest cover maps. "Given the activity around Van Anda around the turn of the century, and the active underground mining in the area, a lot of timber would have been required" (B. Kukulies, pers. comm.). The amount of soil disturbance created at the time is not known.

Approximately 60% of the Priest Lake Community Watershed is on Crown land, which is under the administration of the Ministry of Forests. The Ministry of Forests has approved a forest development plan including provisions for forest harvesting (A20507 Blocks 701P, 702P, 703P, and 704P; and A20489 Block 904P) in the Priest Lake Community Watershed (B.C. MOF 2001).

Threats

Population threats

These species are found in Emily, Priest, and Spectacle lakes—all in the Van Anda Creek drainage, Texada Island—and nowhere else in the world. Van Anda Creek itself flows from Spectacle Lake at the upper end of the drainage basin directly into Priest Lake and then into Emily Lake. Van Anda Creek also flows from Emily Lake to tidewater.

An unauthorized introduction of catfish (*Ameiurus nebulosis*) into Hadley Lake, on Lasqueti Island, occurred in the 1990s, and the limnetic and benthic stickleback species that formerly lived in the lake have now been assessed by COSEWIC (2002) as being extinct. Direct predation by the catfish is strongly implicated. If catfish, or any other species that preys on sticklebacks, were to be introduced into Emily, Priest, or Spectacle lakes, the Vananda Creek pair of sticklebacks might easily be driven to extinction.

Signal crayfish (*Pacifastacus leniusculus*) have been introduced into Garden Bay Lake on the Sechelt Peninsula with "devastating" effects on the allopatric stickleback population in that lake (S.A. Foster, pers. comm.). These crayfish, also introduced into Enos Lake on Vancouver Island, appear to have disrupted the habitat of that lake's pair of stickleback species. Although crayfish may directly prey upon stickleback eggs (S.A. Foster, pers. comm.), the major impacts appear to be through habitat-disruptive mechanisms, three of which have been hypothesized (D. Schluter, pers. comm.). First, the crayfish stir up bottom sediments, creating turbid water. In Enos Lake, the crayfish are so numerous that their collective ability to create turbid water conditions is real. Second, the crayfish consume large quantities of vegetative matter in the littoral zone of Enos Lake. A lack of vegetative matter could interfere with the breeding microhabitat requirements of the two stickleback species, thereby leading to a breakdown in assortative mating. Finally, the comparatively large male benthics in Enos Lake might not be growing to their former large size due to a lack of suitable benthos to feed upon, or due to a lack of suitable benthic feeding sites, given the heavy macrophytic feeding habits of the introduced crayfish. Because size of the male sticklebacks is one of the visual cues that female sticklebacks use in their selection of mates, the recently-smaller benthic males could now be confused for limnetic males in the assortative mating process. This too might lead to hybridization and a subsequent collapse of the species pair.

An introduction of crayfish into the Van Anda Creek watershed is therefore considered to be a threat to the Vananda Creek species pair, given the similarity of habitats, especially the breeding microhabitats, between Enos Lake and Emily, Priest, and Spectacle lakes.

Coastal cutthroat trout (*Oncorhynchus clarki*) feed on sticklebacks, and they do reside in Emily, Priest, and Spectacle lakes. So far, they seem to coexist with the sticklebacks, at least at current population levels. However, any increase in the number of cutthroat trout in the lakes, for example through a stocking program, could upset the current balance between the stickleback and trout populations.

Habitat threats

The Vananda stickleback species pairs are potentially more sensitive to changes in habitat and water quality than normal populations of sitcklebacks. Relatively minor changes in environmental conditions could result in the limnetic and benthic species hybridized and collapsing into a hybrid swarm. The limnetic and benthic species are maintained as true species with limited gene flow by reproductive isolating mechanisms including strong assortative mating, low hybrid survival relative to the parent species, and relatively high growth and survival of the limnetic and benthic morphologies in their respective habitats. Changes in water quality that affect transparency (e.g., increases in turbidity or dissolved organic carbon) may interfere with females discriminating between males of either species, and an increase in hybridization frequency by as little as 3% (D. Schluter, pers. comm.) is sufficient to cause the two species to collapse into a hybrid swarm. Changes in the relative productivity of benthic relative to limnetic prey (zooplankton) associated with changes in water quality (nutrients or suspended solids) may also affect relative growth rates of either species or their hybrids. A decrease in benthic invertebrate production associated with environmental disturbances may lead to decreased growth (and therefore fitness) of benthic juveniles relative to hybrids, thereby selecting against the benthic species rather than hybrids. Decreased growth of benthics could also prevent them from growing large enough to be discriminated as benthic males by breeding limnetic females.

Recent changes in water and/or microhabitat characteristics in Enos Lake appear to have precipitated an increase in hybridization between this lake's limnetic and benthic species with a consequential loss of reproductive potential and the likelihood of collapse of both species (Kraak et al. 2001). Turbidity (very fine suspended solids) in the water is strongly implicated.

For a pair of cichlid species (family Cichlidae) in Lake Victoria in Africa, turbidity is the likely cause of the breakdown of assortative mating. In these species, as in the sympatric stickleback pairs in British Columbia, one of the assortative mating cues is the red colouration of the males; a slight difference in colour allows the females to distinguish between males of the two sympatric species. With turbidity, the females appear less able to distinguish between males of the two species (Seehausen et al. 1997).

In recent laboratory experiments using Enos Lake limnetic and benthic sticklebacks, Boughman (2001) observed that, in relatively clear water, blue and red are "high-contrast signal colours" (p. 944), meaning that females can use the slightly more red or slightly more blue colouration on the males to distinguish between limnetic and benthic males. In turbid water, this visual cue is masked or lost because the light that does penetrate the turbid water is "redshifted" (i.e., the ambient light in the water fails to illuminate the slight colour difference between the limnetic and benthic males). As a result, it has been suggested that females may mate with males of the other species (Kraak et al. 2001; D. Schluter, pers. comm.).

Thus, turbidity in the water would appear to be a significant threat to all sympatric stickleback pairs, including the Vananda Creek pair. Turbidity during the breeding season (April through June) would seem to cause a breakdown in the assortative mating between the two species, leading to the collapse of both species by way of hybridization. In addition, the risk to sympatric stickleback pairs, including the Vananda Creek pair, from sediment delivery is significantly higher because of the very short lifespan of the species. Due to the relatively fast turnover of generations, the degree of hybridization or recruitment failure that could occur in the first and/or second breeding period affected by a sediment event could seriously and irreversibly harm the species (T. Hatfield, pers. comm.). However, the degree and duration of the turbidity events that would precipitate such a collapse of these species is currently unknown.

Forest management practices have the potential to result in increased turbidity and sedimentation. Risks to sticklebacks from increased turbidity associated with suspension of very fine sediments is a serious concern, since this may potentially interfere with both mate recognition and zooplankton productivity. Changes in productivity of the benthos and zooplankton may affect viability of the species pairs and their hybrids (see above discussion). Very fine suspended solids are usually associated with erosion from soils with a high clay content, or runoff from logging roads.

Typically, release of suspended sediments into fish-bearing water bodies occurs as a result of altered hydrology or runoff over exposed soils or logging roads. Soils may be exposed during road building, forest harvest, and clearing for building sites. There is broad scientific literature indicating negative behavioural and physiological consequences from high deposition of sediment. The risk to species pairs from sedimentation is, at present, difficult to gauge, but remains a concern.

Forest management may result in other habitat disturbances or alterations. For example, riparian and littoral habitat can be affected by harvest and side-casting from roads. Riparian logging and littoral modifications are of minor intensity at present, but such impacts may increase in the future.

In addition, forestry may have cumulative effects on turbidity, water chemistry, or dissolved organic carbon that may influence water clarity or cause eutrophication.

An active placer mining operation near Priest Lake poses a threat of sediment delivery to one or more of Emily, Priest, and Spectacle lakes, but reports conflict about the amount of aggregate sorting now occurring at this mine. However, any soil disturbance, such as during forest road development or forest harvesting activities but also including natural disturbances, in the forested lands surrounding Emily, Priest, and Spectacle lakes could precipitate an erosion event, which could lead to subsequent sediment delivery into the lakes.

Water levels in Priest and Spectacle lakes are regulated by a dam at the outlet of Priest Lake. This has resulted in an increased surface elevation for Priest Lake and the back-flooding of the section of Van Anda Creek that joins Priest and Spectacle lakes. There are potential consequences resulting from the dam and water management decisions with regard to the regulation of flows and lake level:

- an elevated lake level may result in less suitable littoral habitats and erosion of riparian soils;
- the exposure of littoral areas during periods of drawdown may result in sediment generation during rainfall events:
- any changes in lake level elevation during spawning periods may affect reproductive success; and
- the dam may reduce the opportunity for gene flow with Emily Lake or may enhance gene flow between Priest and Spectacle lakes.

None of these potential issues have been evaluated in the Vananda Creek populations (T. Down, pers. comm.).

Legal Protection and Habitat Conservation

The two Vananda Creek sticklebacks are not legally recognized under the provincial *Wildlife Act*, but are protected by the provincial *Fish Protection Act*, and the habitat provisions of the federal *Fisheries Act*. The *Fish Protection Act* provides the legislative authority for water managers to consider impacts on fish and fish habitats before approving new water licences or amendments to existing licences, or issuing approvals for works in and about streams. However, the *Fish Protection Act* cannot be used to supercede activities authorized under the provincial *Forest Act*, or where the Forest Practices Code or its successor, the *Forest and Range Practices Act*, applies (see Section 7(7), *Fish Protection Act*).

Section 35(1) of the federal *Fisheries Act* prohibits activities that may result "in the harmful alteration, disruption, or destruction of fish habitat." Similarly, Section 36(3) of the Act prohibits the deposition of a "deleterious substance of any type" into waters frequented by fish.

Also of note is the fish habitat policy of the federal Department of Fisheries and Oceans, which includes a goal of "… no net loss of the productive capacity of fish habitat", which is designed to maintain the maximum natural fisheries capacity of streams (Chilibeck et al. 1992).

There are no provincial or federal protected areas in the Van Anda Creek watershed.

Provisions enabled under the Forest Practices Code or its successor, the *Forest and Range Practices Act*, that may help maintain habitat for this species include: ungulate winter range areas; old growth management areas; riparian management areas; community watersheds; coarse woody debris retention, visual quality objectives; and the wildlife habitat feature designation. All of these, except community watersheds, have the ability to protect relatively small portions of streamside vegetation (i.e., a few hundred hectares) along a stream and/or lake shoreline; community watersheds have the potential to protect an entire population of a stream and/or lake resident form.

A major portion of the Van Anda Creek drainage is designated as the Priest Lake Community Watershed, with Priest Lake being the water source for the community of Van Anda. The Code and FRPA do allow forest harvesting in a community watershed, provided that a watershed assessment has been conducted and that the recommendations from the assessment are being followed. A Coastal Watershed Assessment Procedure (CWAP) has been completed for the Priest Lake Community Watershed (Clarke and BaBakaiff 2000; Clarke and Gemeinhardt 2001).

Recovery planning for these species is underway.

Identified Wildlife Provisions

Wildlife habitat area

Goal

Prevent site-specific or cumulative forestry impacts to aquatic habitat or water quality that may lead to hybridization and introgression of stickleback species pairs or population decline in occupied lakes.

Feature

Establish a WHA at known sites (Spectacle Lake, Priest Lake, Emily Lake).

Size

The WHA should include the Crown land portion of the height-of-land watershed upstream of the outlet of Emily Lake, which would include the Crown land portion of the Priest Lake Community Watershed (which includes Priest and Spectacle lakes). This is necessary at least as an interim measure until a recovery strategy and action plans for the Threespine Stickleback species pairs are completed. Work on the recovery strategy is underway and scheduled for completion in 2003.

As the Priest Lake Community Watershed measures 1131 ha (Clarke and Babakaiff 2000), it is estimated that the overall Emily Lake height-of-land watershed would be approximately 1250 ha. With the Crown land portion of the Community Watershed estimated at 60% (B. Kukulies, pers. comm.), and assuming a similar land ownership for the area surrounding Emily Lake, the overall WHA would be expected to be approximately 750 ha. However, the overall height-of-land watershed includes the surface areas of the four lakes (Emily 7.1 ha; Priest 43.7 ha; Spectacle 10.6 ha; and Kirk ±8 ha), the surface areas of the stream channels joining the lakes, and other areas not contributing to the harvestable forest land base (e.g., marshes).

Design

The WHA should include a core area and management zone. The core area should be established around the three occupied lakes and all streams flowing into these lakes. The size of the core area will vary depending on the risk of sedimentation to the lakes but may be between 30–90 m (both sides of streams). The management zone should include the Crown forest lands that drain into these lakes, up to the height of land. It is recognized that these recommendations are more conservative than standard riparian management practices. However, given the international significance of these species and the consequences of an error in judgement (global and irreversible extirpation), it is reasonable to argue for more conservative riparian setbacks and harvesting practices to reduce the risk of potential impacts.

General wildlife measures

Goals

1. Minimize soil disturbance and prevent erosion and sediment delivery to the lakes.
2. Minimize road access.

Measures

Access

- Do not develop new roads in core areas. Construction and maintenance of existing roads must be done in a manner, and at times, that prevent or preclude sediment delivery to any water feature.

Harvesting and silviculture

- Do not harvest or salvage in the core area.
- Plan harvesting of management zone to meet goals of the general wildlife measure
- Conduct silvicultural activities in a manner that prevents or precludes sediment delivery to any water feature.

Pesticides

- Do not use pesticides.

Recreation

- Do not develop trails, recreation sites, facilities, or structures in the core area. In the management zone, restrict recreational developments to those designed to mitigate impacts from recreational activities.

Additional Management Considerations

The management of water levels within Priest and Spectacle lakes should consider the life history requirements of sticklebacks. In particular, significant changes, up or down, in the surface level elevations of the lakes during the breeding season may affect reproductive success. Further, to prevent erosion and sediment delivery to the lakes, riparian soils should not be flooded. In addition, the exposure of littoral habitat should be minimized at all times of the year, but especially during the typical rainy season.

Measures must be taken to prevent the introduction into these lakes of any exotic species that might prey on the sticklebacks, or otherwise disrupt their life history and habitat requirements. Similarly, no measures should be taken that might enhance the "native" cutthroat trout population.

Information Needs

1. The exact extent to which existing and potential sources of soil erosion could result in sediment delivery to one or more of the three lakes. Existing sources include private forest lands surrounding the three lakes, private residential lands surrounding the three lakes, and an active placer mining operation near Priest Lake.
2. The relationship between degrees of turbidity in the species' resident lakes and the resulting rates of hybridization.
3. The effects of crayfish on the breeding and foraging habitats of threespine sticklebacks.

References Cited

Baker, J.A. 1994. Life history variation in female threespine stickleback. *In* The evolutionary biology of the threespine stickleback. M.A. Bell and S.A. Foster (editors). Oxford Univ. Press, Oxford, pp. 144–187.

Bakker, T.C.M. and W.J. Rowland. 1995. Male mating preference in sticklebacks: effects of repeated testing and own attractiveness. Behaviour 132(13–14): 935–949.

Baube, C.L., W.J. Rowland, and J.B. Fowler. 1995. The mechanism of colour-based mate choice in female three-spined sticklebacks: hue, contrast, and configurational cues. Behaviour 132(13–14):979–996.

Bell, M.A. and S.A. Foster. 1994a. Introduction to the evolutionary biology of the threespine stickleback. *In* The evolutionary biology of the threespine stickleback. M.A. Bell and S.A. Foster (editors). Oxford Univ. Press, Oxford, pp. 1–27.

______. 1994b. The evolutionary biology of the threespine stickleback. Oxford Univ. Press, Oxford.

______. [2003]. The case for conserving stickleback populations: protecting an adaptive radiation. Fisheries. Submitted.

Bentzen, P. and J.D. McPhail. 1984. Ecology and evolution of sympatric sticklebacks (*Gasterosteus*): selection for alternative trophic niches in the Enos Lake species pair. Can. J. Zool. 62:2280–2286.

Boughman, J.W. 2001. Divergent sexual selection enhances reproductive isolation in sticklebacks. Nature 411:944–948.

B.C. Ministry of Environment, Lands and Parks. 1999. Stickleback species pairs. Wildlife in British Columbia at Risk brochure series. Victoria, B.C. 6 p.

B.C. Ministry of Forests (B.C. MOF). 2001. Sunshine Coast Forest District forest development plan (2001–2005), timber sale licence (major). Powell River, B.C.

Clarke, J. and S. Babakaiff. 2000. Watershed Assessment (CWAP) for Priest Lake, Texada Island, BC, Final Report. EBA Engineering Consultants, Vancouver, B.C. EBA File No. 0801-00-81528.

Clarke, J. and R. Gemeinhardt. 2001. Surface erosion field assessment for blocks 403P and 404P in the Priest Lake Watershed, and hydrologic assessment of Suspension Bridge Creek, Texada Island. EBA Engineering Consultants, Vancouver, B.C. EBA File No. 0801-00-81547.

Committee on the Status of Endangered Wildlife in Canada (COSEWIC). 2002. Canadian species at risk. Available from: http://www.speciesatrisk.gc.ca

Crandall, K.A., O.R.P. Bininda-Emonds, G.M. Mace, and R.K. Wayne. 2000. Considering evolutionary processes in conservation biology. Trends Ecol. Evol. 15:290–295.

Foster, S.A. 1994. Evolution of the reproductive behaviour of threespine stickleback. *In* The evolutionary biology of the threespine stickleback. M.A. Bell and S.A. Foster (editors). Oxford Univ. Press, Oxford, pp. 381–398.

Foster, S.A., J.A. Baker, and M.A. Bell. 2003. The case for conserving threespine stickleback populations: protecting an adaptive radiation. Fisheries 28(5): 10 – 18.

Hatfield, T. 1998. Status of the stickleback species pair, *Gasterosteus* spp., in Balkwill, British Columbia. Rep. prepared by Westland Resource Group for B.C. Min. Environ., Lands and Parks, Fisheries Br., Victoria, B.C. 25 p.

Hatfield, T. 2001a. Status of the stickleback species pair, *Gasterosteus* spp., in Hadley Lake, Lasqueti Island, British Columbia. The Canadian Field-Naturalist 115(4):579–583.

Hatfield, T. 2001b. Status of the stickleback species pair, *Gasterosteus* spp., in the Vananda Creek watershed of Texada Island, British Columbia. The Canadian Field-Naturalist 115(4):584–590.

Hatfield, T, and J. Ptolemy. 2001. Status of the stickleback species pair, *Gasterosteus* spp., in Paxton lake, Texada Island, British Columbia. The Canadian Field-Naturalist 115(4):59–596.

Hatfield, T. and D. Schluter. 1999. Ecological speciation in sticklebacks: environment dependent fitness. Evolution 53:866–879.

Hyatt, K.D. and N.H. Ringler. 1989a. Role of nest raiding and egg predation in regulating population density of threespine sticklebacks (*Gasterosteus aculeatus*) in a coastal British Columbia lake. Can. J. Fish. Aquat. Sci. 46:372–383.

______. 1989b. Egg cannibalism and the reproductive strategies of threespine sticklebacks (*Gasterosteus aculeatus*) in a coastal British Columbia lake. Can. J. Zool. 67:2036–2046.

Kraak, S.B.M., B. Munweiler, and P.J.B. Hart. 2001. Increased numbers of hybrids between benthic and limnetic three-spined sticklebacks in Enos Lake, Canada; the collapse of a species pair? J. Fish Biol. 58:1458–1464.

Lavin, P.A. and J.D. McPhail. 1985. The evolution of freshwater diversity in threespine stickleback (*Gasterosteus aculeatus*): site-specific differentiation of trophic morphology. Can. J. Zool. 63:2632–2638.

McPhail, J.D. 1984. Ecology and evolution of sympatric sticklebacks (*Gasterosteus*): morphology and genetic evidence for a species pair in Enos Lake, British Columbia. Can. J. Zool. 62:1402–1408.

______. 1989. Status of the Enos Lake stickleback species pair (*Gasterosteus* spp.). Can. Field-Nat. 103(2):216–219.

______. 1992. Ecology and evolution of sympatric sticklebacks (*Gasterosteus*): evidence for a species pair in Paxton Lake, Texada Island, British Columbia. Can. J. Zool. 70:361–369.

______. 1994. Speciation and the evolution of reproductive isolation in the sticklebacks (*Gasterosteus*) of south-western British Columbia. *In* The evolutionary biology of the threespine stickleback. M.A. Bell and S.A. Foster (editors). Oxford Univ. Press, Oxford, U.K., pp. 399–437.

Moodie, G.E.E. 1972. Morphology, life history and ecology of an unusual stickleback (*Gasteosteus aculeatus*) in the Queen Charlotte Islands, Canada. Can. J. Zool. 50:721–732.

Nagel, L. and D. Schluter. 1998. Body size, natural selection, and speciation in sticklebacks. Evolution 52:209–218.

NatureServe Explorer. 2002. An online encyclopedia of life [Web application]. Version 1.6. Arlington, Va. Available from: http://www.natureserve.org/explorer

Rundle, H.D., L. Nagel, J. Boughman, and D. Schluter. 2000. Natural selection and parallel speciation in sympatric sticklebacks. Science 287:306–308.

Schluter, D. 1993. Adaptive radiation in sticklebacks: size, shape, and habitat use efficiency. Ecology 74:699–709.

______. 1995. Adaptive radiation in sticklebacks: trade-offs in feeding performance and growth. Ecology 76:82–90.

______. 2000. The ecology of adaptive radiation. Oxford Univ. Press, Oxford, New York.

Schluter, D. and J.D. McPhail. 1992. Ecological character displacement and speciation in sticklebacks. Am. Nat. 140:85–108.

Seehausen, O., J.J.M. van Alphen, and F. Witte. 1997. Cichlid fish diversity threatened by eutrophication that curbs sexual selection. Science 277:1808–1811.

Taylor, E.B. and J.D. McPhail. 1999. Evolutionary history of an adaptive radiation in species pairs of threespine sticklebacks (*Gasterosteus*): insights from mitochondrial DNA. Biol. J. Linn. Soc. 66:271–291.

Vamosi, S.M. and D. Schluter. 1999. Sexual selection against hybrids between sympatric stickleback species: evidence from a field experiment. Evolution 53:874–879.

Wood, P.M. 2003. Will Canadian policies protect British Columbia's endangered pairs of sympatric sticklebacks? Fisheries 28(5):19 – 26.

Wooton, R.J. 1973. The effect of size of food ration on egg production in the three-spined stickleback, *Gasterosteus aculeatus* L. J. Fish Biol. 5:89–96.

______. 1994. Energy allocation in the threespine stickleback. *In* The evolutionary biology of the threespine stickleback. M.A. Bell and S.A. Foster (editors). Oxford Univ. Press, Oxford, U.K., pp. 114–143.

Personal Communications

Down, T. 2003. Min. Water, Land and Air Protection, Biodiversity Branch, Victoria, B.C.

Foster, S.A. Dr. 2002. Clark Univ., Dep. Biology, Worcester, Mass.

Hatfield, T. Dr. 2003. Solander Ecological Research, Victoria, B.C.

Kukulies, B. 2003. Min. Forests, Sunshine Coast Forest District, Powell River, B.C.

Norris, J.G. 2003. Min. Water, Land and Air Protection, Biodiversity Branch, Victoria, B.C.

Schluter, D. Dr. 2002. Univ. B.C., Dep. Zoology, Vancouver, B.C.

COASTAL GIANT SALAMANDER

Dicamptodon tenebrosus

Original prepared by Barbara E. Johnston

Species Information

Taxonomy

The Coastal Giant Salamander belongs to the Dicamptodontidae family (Good 1989). This group was originally considered to be a subfamily of Ambystomatidae. However, taxonomic analysis by Edwards (1976) and Estes (1981) found *Dicamptodon* to have several unique morphological and neurological traits that warrant distinct family status. Dicamptodontidae is an ancient lineage (Peabody 1954) that first appears in the fossil record of the lower Pliocene.

Within the subfamily Dicamptodontinae, Good (1989) recognized four distinct species on the basis of allozymes: *Dicamptodon aterrimus, D. copei, D. ensatus, and D. tenebrosus.* Prior to this analysis, *D. tenebrosus* and *D. ensatus* were considered to be one species called *D. ensatus*. These two species are similar in appearance and life history, but geographically disjunct. There are no recognized subspecies of *D. tenebrosus*.

Description

Coastal Giant Salamander larvae are ~33–35 mm in total length at hatching (Nussbaum and Clothier 1973). They are dark dorsally with light underbellies, have shovel-shaped heads, gills, and tail fins. If larvae transform into terrestrial adults, they usually do so between the sizes of 92 and 166 mm total length (Nussbaum et al. 1983). Some adults do not transform and remain obligate streams dwellers. These neotenes can grow up to 351 mm total length (Nussbaum et al. 1983). Terrestrial adults are heavy bodied and broad headed. They are dark brown to black dorsally and usually marbled with tan or copper (Farr 1989). Larger adults are noticeably less marbled than small individuals, suggesting these markings fade with age (B. Johnston, pers. obs.). Coastal Giant Salamanders are the only salamanders capable of true vocalization, with adults emitting bark-like cries when disturbed (Nussbaum et al. 1983).

Distribution

Global

The range of the Coastal Giant Salamander extends along the western coast of North America from southwestern British Columbia, through the Cascade and Coast Ranges, to northwestern California (Nussbaum and Clothier 1973; Nussbaum et al. 1983).

British Columbia

In British Columbia, the Coastal Giant Salamander is restricted to the Chilliwack River Valley and a few small nearby tributaries of the Fraser River. In this region, larvae have been recorded in ~60 headwater streams (Farr 1989; Haycock 1991; Richardson and Neill 1995, 1998). Their range appears to be continuous, extending from the west side of Vedder Mountain to the slopes east of Chilliwack Lake (Richardson and Neill 1995). The population on the west side of Vedder Mountain may now be isolated because of modifications to the drainage system of this area (Farr 1989).

Forest region and district

Coast: Chilliwack

Ecoprovinces and ecosections

COM: NWC, SPR

GED: FRL, GEL

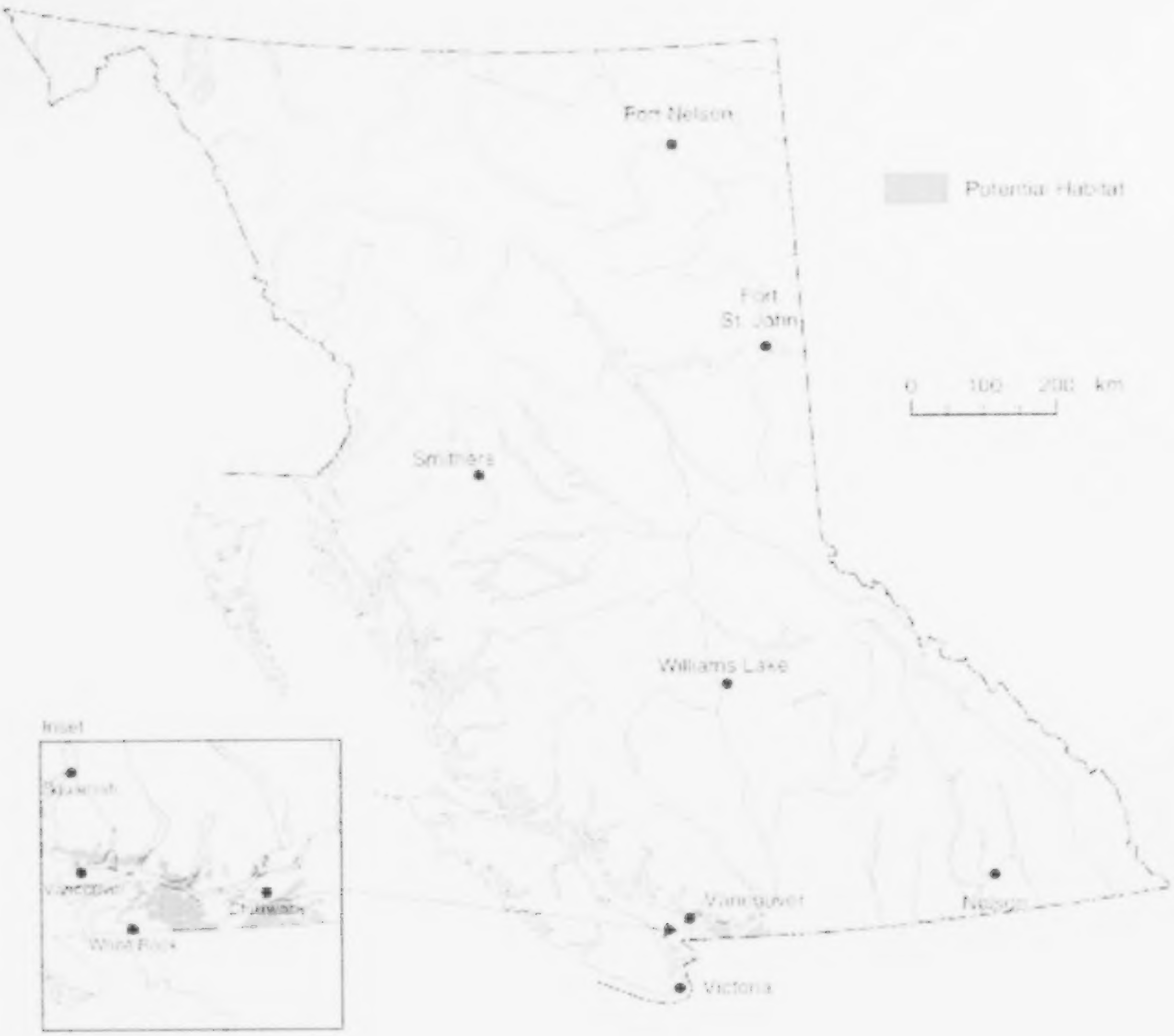
Biogeoclimatic units

CWH: dm, ds1, ms1, vm2, xm1

MH: mm1, mm2

Coastal Giant Salamander

(Dicamptodon tenebrosus)


Fort Nelson
Potential Habitat
Fort St. John
0 100 200 km
Smithers
Williams Lake
Inset
Squamish
Vancouver
Chilliwack
White Rock
Vancouver
Nelson
Victoria

Note: This map represents a broad view of the distribution of potential habitat used by this species. The map is based on several ecosystem classifications (Ecoregion, Biogeoclimatic and Broad Ecosystem Inventory) as well as current knowledge of the species' habitat preferences. This species may or may not occur in all areas indicated.

Broad ecosystem units

CR, CW, FR, LL, LS, MF

Elevation

Sea level to 2160 m

Life History

Diet and foraging behaviour

Both larval and adult Coastal Giant Salamanders are opportunistic feeders. The aquatic larvae feed nocturnally on aquatic insects (i.e., caddisflies, stoneflies, dipterans, and beetles), benthos, small fish, and Tailed Frog larvae (Antonelli et al. 1972; Nussbaum et al. 1983; Parker 1994). Terrestrial adults feed on land snails, slugs, beetles, caddisfly larvae, moths, flies, small mammals such as shrews, and other amphibians (Stebbins 1951). Other unusual items such as lizards, garter snakes, and feathers have been found in the stomach contents of adults (Bury 1972; Nussbaum et al. 1983). Cannibalism has been noted in both larval and adult life stages of this species (Anderson 1960; Nussbaum et al. 1983).

Reproduction

Coastal Giant Salamanders are believed to breed once every 2 years (Nussbaum 1976). In California and Oregon, breeding can occur in either spring or fall (Nussbaum et al. 1983). Preliminary evidence from British Columbia suggests the timing of breeding is variable and may occur throughout the May to October active season (Haycock 1991; Ferguson 1998). Age at first reproduction remains unknown.

Montane streams are implied as breeding habitat for this species based on the observation of very small larvae in this habitat type (Haycock 1991; Nussbaum 1969; Henry and Twitty 1940). Only four known nest sites have been described from the field, all within the United States (Jones et al. 1990). The nests were located (1) in a stable talus and earth bank adjacent to a stream (Nussbaum 1969), (2) within a rock pile at the base of a waterfall (Nussbaum 1969), (3) on a submerged piece of lumber from a bridge crossing a fast flowing stream (Henry and Twitty 1940) and (4) on a partly rotted log in a riffle at the edge of a small stream (Jones et al. 1990).

On the basis of a few field and aquaria observations, Nussbaum et al. (1983) suggested that courtship occurs in hidden, water-filled nest chambers beneath logs and stones.

Males deposit up to 16 spermatophores. Females pick up one or two spermatophores with their cloacae and deposit a clutch of 135–200 eggs in the nest chamber (Nussbaum et al. 1983). Eggs are usually attached singly on the chamber roof.

In the field, adult salamanders have been observed near a developing clutch. This observation has been interpreted as females tending their own eggs (Farr 1989). Nussbaum et al. (1983) state a female will stay in the nest until the eggs hatch and the young abandon the nest chamber, a period of up to 200 days.

Coastal Giant Salamanders take approximately 35 days to develop to tail bud stage (Nussbaum 1969) and a further 5 months until hatching (Henry and Twitty 1940). Newly hatched larvae remain buried in the substrate and attached to their yolk sac for a further 3–4 months before appearing in streams at 45–51 mm in total length (Nussbaum and Clothier 1973). The larval period is believed to last between 2 and 6 years, averaging 3–4 years (Duellman and Trueb 1986; Ferguson 1998). Larval survivorship until adulthood is estimated at ~1–4% (Ferguson 1998), with predation and desiccation acting as the chief agents of mortality (Nussbaum and Clothier 1973).

At the end of the larval period, Coastal Giant Salamanders either transform into terrestrial salamanders or remain in their natal habitat as neotenes. The frequency of neoteny varies between populations and it is unclear whether this phenomenon is genetically or environmentally determined. The lifespan of this species is unknown. Studies of similarly sized aquatic salamanders suggest they may live up to 25 years (Duellman and Trueb 1986).

Home range

In aquaria, Coastal Giant Salamanders are reported to exhibit territorial behavior (Nussbaum et al. 1983). Terrestrial Coastal Giant Salamanders do not appear to occupy a home range. Over the course of one active season (June to September), individuals rarely returned to previously visited locations (Johnston 1998).

Site fidelity, movement, and dispersal

Coastal Giant Salamanders are highly sedentary, generally spending their entire life cycle in one creek (Farr 1989). Two mark-recapture studies conducted on larvae in the Chilliwack Valley found, respectively, that 73% of larvae remained within 10 m of their initial location of capture over 3 years (Neill 1998), and that only 10% of larvae moved farther than 20 m over 2 years (Ferguson 1998).

Terrestrial adults travel farther than larvae (commonly moving 10–50 m over a short time), but rarely move between streams (Johnston 1998). A radio-telemetry study in the Chilliwack Valley found that terrestrial adults are primarily active at night, with 70% of all movements occurring between dusk and dawn. The animals moved more frequently when it was raining. During dry periods, their movements were restricted to times of low temperatures (Johnston 1998). Based on the frequency and distance of movements, Johnston (1998) estimated that the probability of a terrestrial adult dispersing to an adjacent stream 0.5 km away was well below 1 in 1000 over the yearly active period. A genetic study conducted in the Chilliwack Valley found subpopulations to be moderately linked, indicating at least some dispersal between adjacent streams (Curtis and Taylor 2003).

The movement and dispersal patterns of juvenile Coastal Giant Salamanders (individuals recently transformed from aquatic to terrestrial phase) have not been studied. It is possible that juveniles are responsible for most of the dispersal, as is the case in many other species including some amphibians (Horn 1983; Duellman and Trueb 1986).

Habitat

Structural stage

4: pole/sapling
5: young forest
6: mature forest
7: old forest

Usually associated with structural stages 6 and 7, but have been recorded in stages 4–7. Habitat use may be more associated with specific habitat features than with structural stage.

Important habitats and habitat features

Aquatic

Suitable habitat for aquatic Coastal Giant Salamanders is generally found in clear, cool, fast-flowing and well-oxygenated streams with step-pool morphology and sufficient hiding cover (i.e., rocks, debris, and overhanging stream banks). Investigations into habitat use suggest that larvae predominantly use pocket pools (pools of small size) (Haycock 1991; Mallory 1996; Hatziantoniou 1999). Both stream depth and stream width are good predictors of larval salamander abundance, with abundance frequently decreasing with increasing wetted width (Richardson and Neill 1995) and with increasing depth (Southerland 1986; Tumlinson et al. 1990). Larval abundance has also been positively correlated with the number of substrate crevices and cover objects available (Hall et al. 1978; Murphy and Hall 1981; Conner et al. 1988; Parker 1991).

Terrestrial

Suitable terrestrial habitat is generally found in moist forested areas with ample hiding cover and in close proximity to streams. Eighty-four percent ($n = 19$) of the terrestrial adults captured using time-constrained searches in unmanaged forests in Oregon were found within 10 m of a stream (Vesely 1996). Johnston (1998) radio-tracked 18 terrestrial Coastal Giant Salamanders in old-growth and second-growth habitat in the Chilliwack and Nooksack River valleys. On average, 67% of each animal's recorded locations were within 5 m of the water's edge. The most common refuge locations used by terrestrial adults in this study were in/under coarse woody debris (38% of recorded refuges), underground (likely in small mammal burrows and root channels) (31%), and under rocks (26%). Any structure that provides a moist microsite appears to make a suitable resting site. When using coarse woody debris, terrestrial Coastal Giant Salamanders appear to select older wood in advanced stages of decay (classes 3–5) over newly fallen wood (Johnston 1998). Overwintering habitat does not appear to be a limiting factor for terrestrial adults. They tend to overwinter in the same types of refuges used throughout the active season, most commonly in underground burrows and seeps (B. Johnston, pers. obs.).

Suitable nesting sites may be the most critical habitat attribute for Coastal Giant Salamanders (Farr 1989). Only four nest sites have been described from the field (Henry and Twitty 1940; Nussbaum 1969; Jones et al. 1990). Each was located in a secure area (under rocks or wood) in or adjacent to a stream.

Conservation and Management

Status

The Coastal Giant Salamander is on the provincial *Red List* in British Columbia. It is designated as *Threatened* in Canada (COSEWIC 2002).

Summary of ABI status in BC and adjacent jurisdictions (NatureServe Explorer 2002)

BC	CA	OR	WA	Canada	Global
S2	S?	S4	S5	N2	G5

Trends

Population trends

Population estimates for Coastal Giant Salamanders are very difficult to determine. The terrestrial life stage is primarily fossorial (only above ground and visible about 1% of the time; Neill 1998) and aquatic individuals are remarkably discrete within streams. Roughly estimated, the population of Coastal Giant Salamanders in British Columbia is ~13 000 terrestrial adults and 4500–9000 neotenic adults (Ferguson and Johnston 2000). Coastal Giant Salamanders have been found in 15 of 20 stream systems in the Chilliwack Valley and associated areas, for a total of 75 occupied streams.

No long-term study of Coastal Giant Salamanders has been conducted to monitor the population's stability in the Chilliwack area. The Sumas Lake and the Vedder River areas may have historically supported populations of this species. In the 1920s, these populations were likely lost when Sumas Lake was drained for agricultural purposes and Vedder Creek was channeled north, becoming the VedderCanal.

Habitat trends

Suitable habitat is declining in British Columbia. The Lower Mainland is the most populated area of the province. Since 1827, the area of coniferous forest declined from 71 to 54% in the lower Fraser Basin ecosystem, while urban and agriculture use increased by 26% (Boyle et al. 1997).

Headwater streams receive little or no protection during timber harvesting. Timber harvesting is occurring throughout the Chilliwack River Valley. In the past 15 years (since ~1985), ~2500 ha have been logged (either clearcut or partial cut) within the known range of the Coastal Giant Salamander (MOF, Chilliwack Forest District). Following an 80-year harvest rotation, much of the remaining mature second growth will likely undergo second rotation cutting beginning around 2013. Urban development also continues to progress east up the Chilliwack Valley and into surrounding hillsides. Increasing habitat fragmentation (forest and stream habitats) is further reducing the quality of the remaining habitat.

Threats

Population threats

Like all amphibians, Coastal Giant Salamanders are highly dependent on moisture for dermal respiration. Transformed adults receive ~66% of their oxygen through the skin (Clothier 1971) and are thus sensitive to a loss of shading and cover objects. This water dependence limits the habitats they can exploit.

Studies conducted in the Chilliwack Valley suggest that both larval and terrestrial Coastal Giant Salamanders have limited dispersal tendencies. From 1996 to 1998, W.E. Neill (unpubl. data) found that fewer than 2% of marked larvae (*n* >2500) traveled >50 m annually. Mean annual movements were estimated at <2 m from the site of first capture. Similarly, Ferguson (1998) found that 90% of marked larvae moved <20 m (cumulative distance) over 1 year. In 1996 and 1997; Ferguson (2000) experimentally depleted 25–40 m reaches of four streams in the Chilliwack Valley to assess recolonization rates. One year after depletion, only 4–5% of the marked larvae from neighbouring reaches had colonized the depleted area. Ferguson (2000) estimated that full recolonization of a 400 m disturbed reach would require 8–55 years. Terrestrial Coastal Giant Salamanders also appear to have limited dispersal. Using a dispersal probability model developed from radio-telemetry data, Johnston (1998) concluded that the probability of a terrestrial adult dispersing between streams in the Chilliwack Valley was far less than 1 in 1000 over the yearly active period.

Dispersal or recolonization limitation in this species is supported by survey work conducted by Richardson and Neill (1995) in the Chilliwack Valley, where Coastal Giant Salamanders were detected in only 22 of 59 (37%) seemingly habitable streams. Results of a transplant experiment conducted in 1996 in the Chilliwack Valley, in which 53 larvae were introduced into an unoccupied stream, suggest that at least some of these uninhabited streams are able to sustain populations of aquatic giant salamanders (W.E. Neill, unpubl. data). Larval survival and growth estimates in the 2 years following introduction were indistinguishable from those at naturally occupied streams.

Several fish species have been shown to prey on giant salamander larvae, and it has been suggested that fish stocking in the Chilliwack River may inflict significant mortality on this species (Orchard 1984).

Coastal Giant Salamanders reach the northern extent of their range 19.5 km north of the Canada–U.S. border. Populations found in the Chilliwack region may therefore be particularly vulnerable. Populations on the periphery often have lower population densities, slower growth rates, and lower fecundity than those in the centre of a species' range (Hengeveld 1990; Lawton 1993). This lower viability is presumably due to climatic, competitive, or predation gradients, which increase towards range margins and, ultimately, limit species expansion. Larval densities and growth rates in British Columbia (Ferguson 1998; W.E. Neill, unpubl. data) appear to be lower than reported in Oregon (Nussbaum and Clothier 1973), the centre of the species range. The larval phase tends to be prolonged in Canadian populations (2–3 times longer than in Oregon; Ferguson 1998). If the annual survival rate of larval Coastal Giant Salamanders is relatively consistent across the species' geographic range, the fact that Canadian salamanders take longer to reach adulthood (reproductive age) means that the average survival rate to reproductive age is lower in British Columbia than in areas farther south.

Little is known of the effects of pesticides on Coastal Giant Salamanders. A common herbicide used in the Chilliwack Valley is glyphosate. This chemical is thought to hve low toxicity; however, some authors have suggested that adverse affects my be subtle (Ferguson and Johnston 2000). Ouellet et al. (1997) found a high prevalence of hindlimb deformities in some frog (*Rana* spp.) and toads (*Bufo americanus*) from agricultural sites exposed to pesticide runoff.

Habitat threats

Forest management and urban development are the main threats to the habitats of Coastal Giant Salamanders. There are several possible causes for declines in amphibian populations following forest harvesting. Some direct mortality occurs during logging operations. This has been observed at three sites in the Chilliwack Valley (K. Mallory, pers. comm.). Canopy removal results in microclimatic changes (Chen et al. 1993, 1995; Brosofske et al. 1997) that may increase physiological stress on terrestrial amphibians, leading to reduced fitness or death. Logging and associated road building degrades stream habitat by increasing sedimentation and causing increases in summer stream temperatures (Newbold et al. 1980; Beschta et al. 1987; Hartman and Scrivener 1990). These changes may influence the growth rate of aquatic amphibians, as well as their ability to respire, find food, and take refuge from predators. Streams may become ephemeral after logging or dry up altogether. Given that many amphibian species, including Coastal Giant Salamanders, are obligate stream dwellers for a portion of their life, these changes constitute critical habitat loss.

Most studies of aquatic Coastal Giant Salamanders in the coastal Northwest have inferred logging effects by correlating larval density to the age of the surrounding forest. Results of these studies have been mixed, with some finding reduced density in logged stands (Bury 1983; Bury and Corn 1988; Connor et al. 1988; Corn and Bury 1989; Cole et al. 1997), others finding no effect (Hawkins et al. 1983; Kelsey 1995), and still others finding increased density in logged areas (Murphy et al. 1981; Murphy and Hall 1981). In their recent study conducted in Oregon, Biek et al. (2002) compared the abundance of larvae on the interface of recent clearcuts and mature forest. They found the abundance of larvae in headwater streams to be markedly lower in clearcuts than in downstream mature forest stands. Without examining demographic rates, it is difficult to interpret why abundance varies after logging, increasing at some sites and decreasing at others. Studies conducted on aquatic Coastal Giant Salamanders in the Chilliwack Valley have yielded inconsistent results (Ferguson 1998; Richardson and Neill 1998; Hatziantoniou 1999; W.E. Neill, unpubl. data).

Radio-telemetry studies of Coastal Giant Salamanders in Chilliwack and northwestern Washington suggest that the terrestrial phase of this species may be adversely affected by logging (Johnston 1998; Johnston and Frid 2003). Catch per unit effort was lower in clearcut habitat than in forested habitat, and salamanders in clearcuts altered their behaviour in ways consistent with a water stress hypothesis. In comparison with salamanders at forested sites, animals in clearcuts remained closer to the stream, spent more time in subterranean refuges, had a more restricted range, and were more dependent on precipitation for their movement during the driest field season. These changes in behaviour could reduce the fitness of animals in clearcuts by influencing their ability to find food and mates (Johnston 1998). These findings are consistent with results of a study in Oregon, where Vesely (1996) found terrestrial Coastal Giant Salamanders at fewer logged sites (1 of 13 sites, 7%) than sites with forest cover (5 of 12 sites with riparian buffer strips, 42%).

Curtis and Taylor (2003) also found that Coastal Giant Salamander populations at eight sample streams found had lower levels of genetic variation and heterozygosity in recent clearcut sites than in second-growth or old-forest sites. These results suggest that clearcut logging is associated with low population densities or population bottlenecks.

Logging roads constructed to gain access to timber may act as dispersal barriers to aquatic Coastal Giant Salamanders. Culverts are installed to enable uninterrupted stream flow below the roads. Most culverts, however, extend beyond the road edge, creating a considerable drop to the stream below (>1 m in many instances). Waterfalls created by the culverts likely prevent upstream movements of aquatic salamanders and the effect of the downstream drop is not known.

Farr (1989) cited housing development on the north side of Vedder Mountain as a potential threat to Coastal Giant Salamanders. Urbanization continues throughout the Chilliwack Valley, including in the Vedder Mountain area. The population of the City of Chilliwack has nearly doubled in the past 10 years, and the growth rate is expected to increase as the Vancouver metropolitan area extends up the Fraser Valley. With 20% of the region's population living in rural areas, housing developments are encroaching up mountainsides and into Coastal Giant Salamander habitat.

Legal Protection and Habitat Conservation

The Coastal Giant Salamander is protected in that it cannot be killed, collected, or held in captivity without a permit, under the provincial *Wildlife Act*. In areas where salmonid habitat exists downstream, some protection may be provided by the *Canadian Fisheries Act*.

Some areas of the Chilliwack River Valley receive some level of protection as parks, recreation areas, and ecological reserves. Coastal Giant Salamanders have been detected within Chilliwack Lake Provincial Park (9122 ha). This park is contiguous with a large park (North Cascades National Park) in Washington State. There are anecdotal observations for Cultus Lake Provincial Park (656 ha), Chilliwack River Provincial Park, and Liumchen Ecological Reserve (948 ha). Numbers present are not known (M. Turner, pers. comm.).

The vast majority of this species' habitat falls on Crown land managed for forestry. The results based code may ensure habitat protection through the establishment of old growth management areas, provided these areas overlap sites inhabited by Coastal Giant Salamanders. Habitat is also protected by riparian management recommendations that recommend reserve zones along S1–S3 streams. As is the case with the *Fisheries Act*, however, this does not afford significant habitat protection because Coastal Giant Salamanders rarely occur in fish-bearing streams. Most of this species' habitat falls along small headwater streams (S5 and S6). Riparian management recommendations also recommend that forest practices in management zones adjacent to these streams be planned and implemented to meet riparian objectives such as wildlife, channel stability, and downstream water quality.

Protected areas or special resource management zones created for other species with overlapping ranges with the Coastal Giant Salamander (e.g., Spotted Owl, Pacific Water Shrew, tall bugbane) may afford additional protection.

Identified Wildlife Provisions

Sustainable resource management and planning recommendations

- Establish old growth management areas to protect suitable riparian habitats (i.e., small streams within range of species) or increase forest retention on small streams (i.e., S4–S6) and on stream reaches adjacent to Coastal Giant Salamander WHAs.
- Maximize connectivity of riparian areas.
- Maintain stream flow characteristics and water quality.
- Fall and yard away from stream channels and minimize site disturbance during harvesting to reduce risks of water diversion and stream sedimentation.
- Minimize the use of chemical applications within suitable Coastal Giant Salamander habitat.

Wildlife habitat area

Goal

Maintain and link important aquatic and riparian habitats not addressed through strategic or landscape level planning.

Feature

Establish WHAs at streams characterized by (1) presence of Coastal Giant Salamander larvae, (2) year-round flow, (3) small size (<5 m channel width), (4) intermediate gradient, (5) step-pool morphology, (6) stable channel beds, and (7) forest cover. In choosing WHA sites, priority should be given to sites that have the highest density of larvae and low levels of historical harvest, and that are adjacent to mature or old forest, closest to the headwaters, and free of fish.

Size

Typically between 20 and 100 ha depending on site-specific factors such as the number and length of streams included and whether overland connectivity is required.

Design

Wherever possible, include more than one stream or stream reach that contains Coastal Giant Salamanders within the WHA. A 30 m core area and 20 m management zone should be maintained on either side of all stream reaches with the WHA. When a WHA contains upland areas needed to connect adjacent stream reaches, include the upland area as part of the management zone. Maximize connectivity of streams and consider overland dispersal requirements of terrestrial adults in the design of the WHA.

General wildlife measures

Goals

1. Preserve the structure, flow regime, water quality and temperature of within-stream habitat.
2. Maintain microclimatic conditions in adjacent forest areas.
3. Maintain important habitat features such as cover objects (e.g., coarse woody debris), clear cold water, ample food supply, understorey vegetation, and subterranean channels.
4. Maintain connectivity between streams.

Measures

Access

- Do not construct roads or crossings. Approved roads should be constructed with minimum road bed and right-of-way widths, and whenever possible, downslope of WHAs. If constructed upslope, implement sediment-control measures and prevent water diversion.
- Approved crossings should use open-bottom structures (i.e., bridges or open-bottom culverts).
- When no longer in use, roads should be deactivated using methods that minimize the risk of water diversion and stream sedimentation.

Harvesting and silviculture

- Do not harvest in the core area.
- Within all riparian areas in the management zone, use partial harvesting systems that maintain 70% basal area, ensure windfirmness, and maintain forest structure and cover by retention of multi layered canopy and snags. Within all upland areas within the management zone, ensure harvesting maintains shade, microclimatic conditions, coarse woody debris, and ground structure (i.e., small mammal burrows, root channels) to facilitate dispersal between streams.
- Do not salvage timber.
- Fall and yard away from streams.
- Remove slash and debris that inadvertently enters the stream (unless this will destabilize the bank or channel).
- Use silviculture strategies and equipment that minimize ground disturbance.
- Retain wildlife trees, non-merchantable conifer trees, understorey deciduous trees, shrubs, herbaceous vegetation, and coarse woody debris.
- Avoid burning.

Pesticides

- Do not use pesticides.

Recreation

- Do not establish recreation sites.

Additional Management Considerations

Manage stream reaches adjacent to WHAs according to the best management practices outlined in the *Riparian Management Area Guidebook*.

At S5 and S6 streams containing Coastal Giant Salamanders, retain riparian vegetation to provide stream shading.

Minimize debris entering the stream channel from logging operations.

To maintain coarse woody debris, avoid piling or burning residue (leave it well distributed across the stand) and retain non-merchantable material on site.

Recommendations for urban and rural land development are available from the MWLAP lower mainland office.

Avoid introducing fish into waters supporting Coastal Giant Salamanders.

Information Needs

1. Demographic responses of Coastal Giant Salamanders to habitat change (i.e., reproductive success, age-class distribution).
2. Movement and dispersal patterns of juvenile (recently transformed from aquatic to terrestrial phase) Coastal Giant Salamanders.
3. Population trends (long-term monitoring at established sites in the Chilliwack Valley).

Cross References

Coastal Tailed Frog, Keen's Long-eared Myotis, Pacific Water Shrew, Red-legged Frog, Short-eared Owl, Spotted Owl, tall bugbane

References Cited

Anderson, J.D. 1960. Cannibalism in *Dicamptodon ensatus*. Herpetologica 16:260.

Antonelli, A.L., R.A. Nussbaum, and S.O. Smith. 1972. Comparative food habits of four species of stream dwelling vertebrates (*Dicamptodon ensatus, D. copei, Cottus tenius, Salmo gairdneri*). Northwest Sci. 46(4):277–289.

Beschta, R.L., R.E. Bilby, G.W. Brown, L.B. Holtby, and T.D. Hofstra. 1987. Stream temperature and aquatic habitat: fisheries and forestry interactions. *In* Streamside management: forestry and fishery interactions. E.O. Salo and T.W. Cundy (editors). Univ. Wash., Inst. For. Resour., Seattle, Wash., Contrib. 57, pp. 191–232.

Biek, R., L.S. Mills, and R.B. Bury. 2002. Terrestrial and stream amphibians across clearcut-forest interfaces in the Siskiyou Mountains, Oregon. Northwest Sci. 76:129–140.

Boyle, C.A., L. Lavkulich, H. Schreier, and E. Kiss. 1997. Changes in land cover and subsequent effects on lower Fraser Basin ecosystems from 1827 to 1990. Environ. Manage. 21(2):185–196.

Brosofske, K.D., J. Chen, R.J. Naiman, and J.F. Franklin. 1997. Harvesting effects on microclimatic gradients from small streams to uplands in western Washington. Ecol. Appl. 7:1188–1200.

Bury, R.B. 1972. Small mammals and other prey in the diet of the Pacific giant salamander (*Dicamptodon ensatus*). Am. Midl. Nat. 87(2):524–526.

______. 1983. Differences in amphibian populations in logged and old growth redwood forest. Northwest Sci. 57:167–178.

Bury, R.B. and P.S. Corn. 1988. Douglas-fir forests in the Oregon and Washington Cascades: Relation of herpetofauna to stand age and moisture. *In* Management of Amphibians, Reptiles and Small Mammals in North America Symp. Proc., July 19–21, 1988, Flagstaff, Ariz. R.E. Szaro, K.E. Severson, and D.R. Pattons (editors)., pp. 11–22.

Chen, J., J.F. Franklin, and T.A. Spies. 1993. Contrasting microclimates among clear-cut, edge, and interior of old-growth Douglas-fir forest. Agric. For. Meteorol. 63:219–237.

______. 1995. Growing-season microclimatic gradients from clear-cut edges into old-growth Douglas-fir forests. Ecol. Appl. 5:74–86.

Clothier, G.W. 1971. Aerial and aquatic respiration in the neotenic and transformed Pacific giant salamander, *Dicamptodon ensatus* (Eschscholtz). Ph.D. thesis. Oreg. State Univ., Corvallis, Oreg.

Cole, E.C., W.C. McComb, M. Newton, C.L. Chambers, and J.P. Leeming. 1997. Response of amphibians to clear-cutting, burning and glyphosate application in the Oregon Coast Range. J. Wildl. Manage. 61:656–664.

Committee on the Status of Endangered Wildlife in Canada (COSEWIC). 2002. Canadian species at risk. Available from: http://www.speciesatrisk.gc.ca

Conner, E.J., W.J. Trush, and A.W. Knight. 1988. Effects of logging on Pacific Giant Salamanders: influence of age-class composition and habitat complexity. Bull. Ecol. Soc. Am. 69:104–105.

Corn, P.S. and R.B. Bury. 1989. Logging in western Oregon: responses of headwater habitats and stream amphibians. For. Ecol. Manage. 29:39–57.

Curtis, J.M. and E.B. Taylor. [2003].The impacts of forest practices on the population structure of coastal giant salamanders, *Dicamptodon tenebrosus*. In press.

Duellman, W. and L. Trueb. 1986. The biology of amphibians. McGraw-Hill Inc., New York, N.Y.

Edwards, J.L. 1976. Spinal nerves and their bearing on salamander phylogeny. J. Morphol. 148:305–328.

Estes, R. 1981. Gymnophiona, Caudata. Handb. Palaherpetol. 2:1–115.

Farr, A.C.M. 1989. Status report on the Pacific Giant Salamander *Dicamptodon tenebrosus* in Canada. Prepared for the Comm. on the Status of Endangered Wildl. in Canada (COSEWIC), Ottawa, Ont.

Ferguson, H.M. 1998. Demography, dispersal and colonisation of larvae of Pacific Giant Salamanders (*Dicamptodon tenebrosus* Good) at the northern extent of their range. M.Sc. thesis. Univ. B.C., Vancouver, B.C. 131 p.

______. 2000. Larval colonisation and recruitment in the Pacific giant salamander (*Dicamptodon tenebrosus*) in British Columbia. Can. J. Zool. 78:1238–1242.

Ferguson, H.M. and B.E. Johnston. 2000. Status report on the Pacific Giant Salamander *Dicamptodon tenebrosus* in Canada. Prepared for the Comm. on the Status of Endangered Wildl. in Canada (COSEWIC), Ottawa, Ont.

Good, D.A. 1989. Hybridization and cryptic species in *Dicamptodon* (Caudata: Dicamptodontidae). Evolution 43:728–744.

Hariston. 1987. Community ecology and salamander guilds. Cambridge Univ. Press, Cambridge, U.K. 230 p.

Hartman G.F. and J.C. Scrivener. 1990. Impacts of forestry practices on a coastal stream ecosystem, Carnation Creek, British Columbia. Can. Bull. Fish. Aquat. Sci. 223:1–148.

Hatziantoniou, Y. 1999. Habitat assessments for the Pacific Giant Salamander (*Dicamptodon tenebrosus*) in the Chilliwack River Valley at three spatial scales of investigation. Directed studies report. Univ. B.C., Vancouver, B.C. 45 p. Unpubl.

Hawkins, C.P., M.L. Murphy, N.H. Anderson, and M.A. Wilzbach. 1983. Density of fish and salamanders in relation to riparian canopy and physical habitat in streams of the northwestern United States. Can. J. Fish. Aquat. Sci. 40:1173–1185.

Haycock, R.D. 1991. Pacific Giant Salamander *Dicamptodon tenebrosus* – status report. B.C. Min. Environ., Wildl. Br., Victoria, B.C.

Hengeveld, R. 1990. Dynamic biogeography. Cambridge Univ. Press, Cambridge, U.K.

Henry, W.V. and V.C. Twitty. 1940. Contributions to the life histories of *Dicamptodon ensatus* and *Ambystoma gracile*. Copeia 1940(4):247–250.

Horn, H.S. 1983. Some theories about dispersal. *In* The ecology of animal movement. I.R. Swingland and P.J. Greenwood (editors). Clarendon Press, Oxford, U.K., pp. 54–62.

Johnston, B. 1998. Terrestrial Pacific Giant Salamanders (*Dicamptodon tenebrosus* Good): Natural history and their response to forest practices. M.Sc. thesis. Univ. B.C., Vancouver. B.C. 98 p.

Johnston, B. and L. Frid. 2002. Clearcut logging restricts the movements or terrestrial Pacific Giant Salamanders (*Dicamptodon tenebrosus* Good). Can. J. Zool. 80:2170–2177.

Jones, L.L.C., R.B. Bury, and P.S. Corn. 1990. Field observation of the development of a clutch of pacific giant salamander (*Dicamptodon tenebrosus*) eggs. Northwest. Nat. 71:93–94.

Kelsey, K.A. 1995. Responses of headwater stream amphibians to forest practices in Western Washington. Ph.D. thesis. Univ. Wash., Seattle, Wash. 164 p.

Lawton, J.H. 1993. Range, population abundance and conservation. Trends Ecol. Evol. 8:409–413.

Lind, A.J. and H.H. Welsh, Jr. 1990. Predation by *Thamophis couchii* on *Dicamptodon ensatus*. J. Herpetol. 24:104–106.

Mallory, K.T. 1996. Effects of body size, habitat structure, and competition on microhabitat use by larval Pacific Giant Salamanders (*Dicamptodon tenebrosus*). Undergraduate thesis. Univ. B.C., Vancouver, B.C. 63 p.

Murphy, M.L. and J.D. Hall. 1981. Varied effects of clear-cut logging on predators and their habitat in small streams of the Cascade Mountains, Oregon. Can. J. Fish. Aquat. Sci. 38:137–145.

Murphy, M.L.,C.P. Hawkins, and N.H. Anderson. 1981. Effects of canopy modification and accumulated sediment on stream communities. Trans. Am. Fish. Soc. 110:469–478.

NatureServe Explorer. 2002. An online encyclopedia of life [Web application]. Version 1.6. Arlington, Va. Available from: http://www.natureserve.org/explorer.

Neill, W.E. 1998. Recovery of Pacific Giant Salamander populations threatened by logging. Report for World Wildl. Fund, Canada. Unpubl.

Newbold, J.D., D.C. Erman, and K.B. Roby. 1980. Effects of logging on macroinvertebrates in streams with and without buffer strips. Can. J. Fish. Aquat. Sci. 37:1076–1085.

Nussbaum, R.A. 1969. Nests and eggs of the Pacific Giant Salamander, *Dicamptodon ensatus* (Eschscholtz). Herpetologica 25:257–262.

______. 1976. Geographic variation and systematics of salamanders of the genus *Dicamptodon* Strauch (Ambystomatidae). Univ. Mich., Dep. Zool., Ann Arbor, Mich. Misc. Publ. (149). 94 p.

Nussbaum, R.A., E.D. Brodie, Jr., and R.M. Storm. 1983. Amphibians and reptiles of the Pacific Northwest. Univ. Idaho Press, Moscow, Idaho.

Nussbaum, R.A. and G.W. Clothier. 1973. Population structure, growth and size of larval *Dicamptodon ensatus* (Escholtz). Northwest Sci. 47:218–227.

Orchard, S. 1984. Amphibians and reptiles of British Columbia: An ecological review. B.C. Min. For., Res. Br., Victoria, B.C. WHR-15.

Ouellet, M., J. Rodrigue, J.L. DesGranges, and S. Lair. 1997. Hindlimb deformities (ectromelia, ectrodactyly) in free-living anurans from agricultural habitats. J. Wildl. Dis. 33:95–104.

Parker, M.S. 1991. Relationship between cover availability and larval Pacific Giant Salamander density. J. Herpetol. 25:355–357.

______. 1994. Feeding ecology of stream-dwelling Pacific Giant Salamander larvae (*Dicamptodon tenebrosus*). Copeia 1994:705–718.

Peabody, F.D. 1954. Trackways of an ambystomid salamander from the Paleocene of Montana. J. Paleontol. 28:79–83.

Richardson, J.S. and W.E. Neill. 1995. Distribution patterns of two montane stream amphibians and the effects of forest harvest: the Pacific Giant Salamander and Tailed Frog in southwestern British Columbia. Report to the B.C. Min. Environ., Lands and Parks. Unpubl.

______. 1998. Headwater amphibians and forestry in British Columbia: Pacific Giant Salamanders and Tailed Frogs. Northwest Sci. 72:122–123.

Southerland, M.T. 1986. The effects of variation in streamside habitat on the composition of mountain salamander communities. Copeia 1986(3):732–741.

Stebbins, R.C. 1951. Amphibians of western North America. Univ. Calif. Press, Berkeley, Calif.

Tumlinson, R., G.R. Cline, and P. Zwank. 1990. Surface habitat associations of the Oklahoma salamander (*Eurycea tyrenensis*). Herpetologica 46:169–175.

Vesely, D.G. 1996. Terrestrial amphibian abundance and species richness in headwater riparian buffer strips, Oregon Coast Range. M.Sc. thesis. Oreg. State Univ., Corvallis, Oreg.

Personal Communications

Mallory, K. 2000. Univ. B.C., Vancouver, B.C.

Turner, M. 2001. Min. Water, Land and Air Protection. Surrey, B.C.

Coastal Tailed Frog

Ascaphus truei

Original[1] *prepared by Agi Mallory*

Species Information

Taxonomy

Phylogenetic studies have determined that tailed frogs belong in their own monotypic family, Ascaphidae (Green et al. 1989; Jamieson et al. 1993). Recent phylogeographic analysis has determined that coastal and inland assemblages of the tailed frog are sufficiently divergent as to warrant designation as two distinct species: *Ascaphus truei* (coastal) and *Ascaphus montanus* (Rocky Mountain) (Ritland et al. 2000; Nielson et al. 2001). The divergence of coastal and inland populations is likely attributable to isolation in refugia in response to the rise of the Cascade Mountains during the late Miocene to early Pliocene (Nielson et al. 2001).

The Coastal Tailed Frog and Rocky Mountain Tailed Frog are the only members of the family Ascaphidae and are considered the most primitive frogs in the world, representing the basal lineage of the anurans (Nielson et al. 2001).

Description

Tailed frogs have unique morphological adaptations to life in fast-flowing mountain streams. They are the only frog species in North America that breed in cold mountain streams. Adults and juveniles are small (2.2–5.1 cm) with a large head, a vertical pupil, and broad and flattened outer hind toes. They lack tympana (ear membranes) and the ability to vocalize, presumably adaptations to the constant sound of rushing water. The species is commonly known as the tailed frog because males have a short, conical "tail" with which to inseminate females. Adults have a grainy skin that can vary in colour from tan, to chocolate brown, to olive green (Metter 1964; L.A. Dupuis, pers. comm.); fine black speckling generally occurs on paler individuals. There is often a distinct copper bar or triangle between the eyes and snout, with green undertones (Metter 1964).

Tadpoles are roughly 11 mm in length upon hatching, and can reach up to 65 mm long prior to metamorphosis (Brown 1990). They possess a wide flattened oral disc modified into a suction mouth for clinging to rocks in swift currents and grazing periphyton (Metter 1964, 1967; Nussbaum et al. 1983), a ventrally flattened body, and a laterally compressed tail bordered by a low dorsal fin. They are black or light brownish-grey, often with fine black speckling; lighter flecks may or may not be present (L.A. Dupuis, pers. comm.). The tadpoles usually possess a white dot (ocellus) on the tip of the tail and often have a distinct copper-coloured bar or triangle between the eyes and snout. Hatchlings lack pigmentation, and are most easily characterized by the large, conspicuous yolk sac in the abdomen.

Distribution

Global

The Coastal Tailed Frog occurs from northwestern California to Portland Canal and Nass River, north of Prince Rupert, British Columbia throughout the temperate Coast Mountains (Corkran and Thoms 1996; Dupuis and Bunnell 1997).

British Columbia

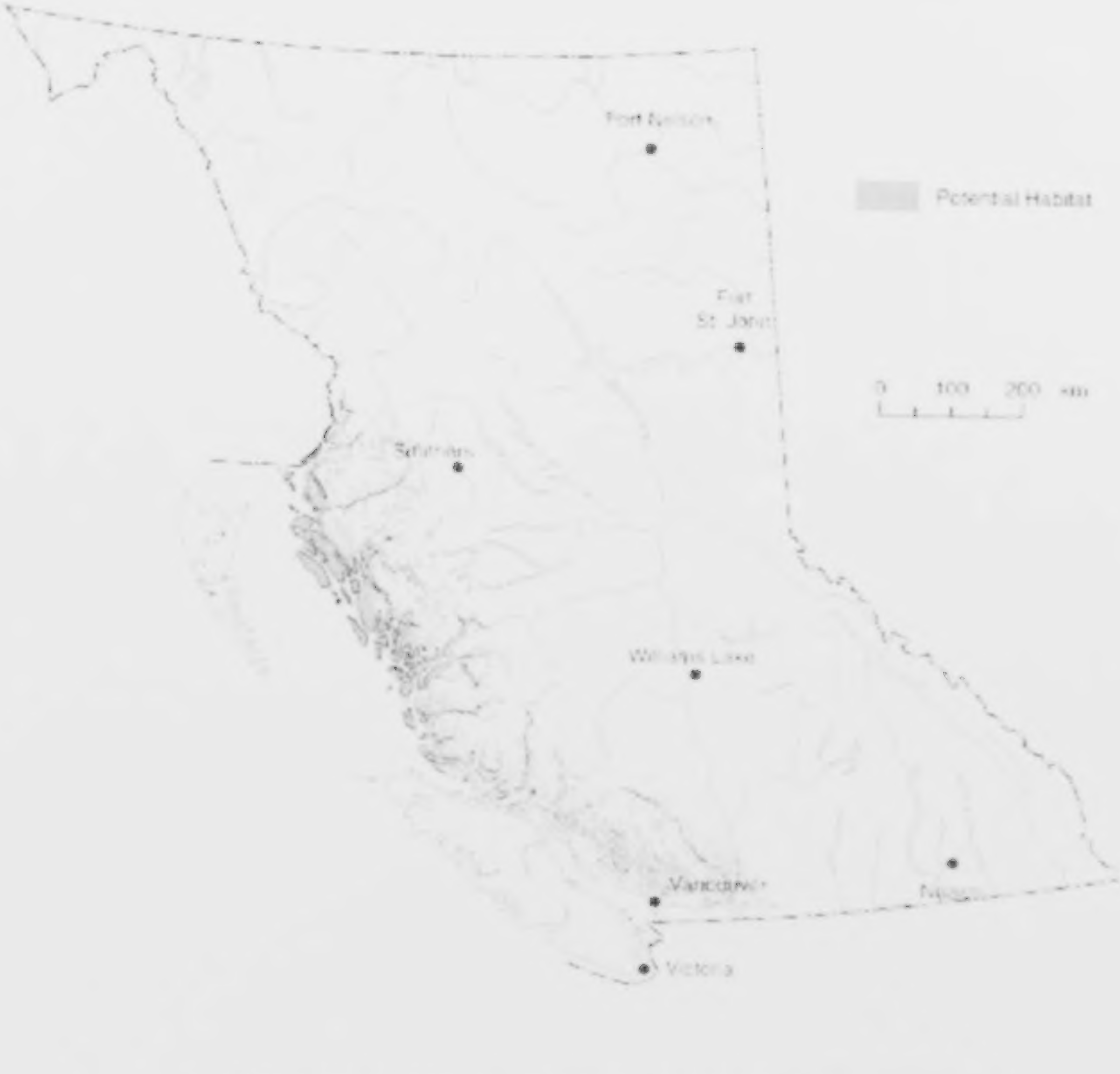
In British Columbia, the Coastal Tailed Frog is restricted to cool permanent mountain streams within the windward and leeward drainages of the Coast Mountains. The distribution extends from the Lower Mainland in the Fraser Basin to Portland Canal and the Nass River on the north coast (Dupuis and Bunnell 1997; Dupuis et al. 2000). Occurrences become scattered and tadpole densities decrease

---

[1] Volume 1 account prepared by L. Dupuis.

Coastal Tailed Frog

(Ascaphus truei)



Fort Nelson
Potential Habitat
Fort St. John
0 100 200 km
Smithers
Williams Lake
Vancouver
Nelson
Victoria

Note: This map represents a broad view of the distribution of potential habitat used by this species. The map is based on several ecosystem classifications (Ecoregion, Biogeoclimatic and Broad Ecosystem Inventory) as well as current knowledge of the species' habitat preferences. This species may or may not occur in all areas indicated.

north of latitude 54° N. The most westerly occurrences are from islands on the mid- and northern coast of British Columbia, and from Namu and Boswell Inlet in the Hecate Lowlands (Dupuis et al. 2000). The most easterly occurrences are from the Cayoosh Ranges between Pemberton and Lillooet, Cathedral Provincial Park, south of Princeton, and Penticton (Dupuis et al. 2000; Gyug 2000). In the eastern portion of its range, cold creek temperatures limit distribution (Dupuis and Friele 2003).

Forest regions and districts

Coast: Campbell River (mainland), Chilliwack, North Coast, North Island (mainland), Squamish, Sunshine Coast

Northern Interior: Kalum, Skeena Stikine

Southern Interior: Cascades, Okanagan Shuswap (Penticton)

Ecoprovinces and ecosections

COM: CPR, EPR, HEL, KIM, KIR, NAM, NPR, NWC, OUF, SBR, SPR

GED: FRL, GEL

SOI: HOR, LPR, OKR, PAR, SCR, STU

Biogeoclimatic units

AT: p

CWH: dm, ds1, ds2, ms1, ms2, vh1, vh2, vm, vm1, vm2, wm, ws1, ws2, xm1

ESSF: dc2, mw, wv, xc

ICH: mc2

IDF: dk2, ww, xh1

MH: mm1, mm2

MS: dm2

Broad ecosystem units

CB, CR, FS, RR, RS, SM, SR, YB
CH, CW, FR, HS, MF – on south-facing slopes only
AV, RR, WR, (SS in IDFdk2, IDFww)
SF (into MSdm2 in OKR, STU)

Elevation

From sea level to 2140 m

Life History

Diet and foraging behaviour

Adults and juveniles forage primarily at night along the creek on a variety of items, including spiders and other terrestrial arthropods such as ticks, mites, collembolans (snow fleas), and various insects as well as snails (Metter 1964). Unlike most frogs and toads, tailed frogs do not have their tongue attached at the front of their mouth and therefore lack the ability to flip it out to catch prey (Green and Campbell 1984).

Tailed frog tadpoles are primary consumers that feed largely on diatoms that they scrape from submerged rocks (Metter 1964; Bury and Corn 1988). Other components of their diet include conifer pollen and small quantities of filamentous algae. In some streams, tailed frog tadpoles may function as the dominant herbivore (Lamberti et al. 1992).

Reproduction

Tailed frogs are the longest lived anuran species (15–20 years), and have the longest larval period and longest time to sexual maturity of all North American frogs (Brown 1975, 1989). They reach sexual maturity at 8 or 9 years of age (Daugherty and Sheldon 1982). Courtship takes place in the water in early fall (September–October). Tailed frogs are among the few frog species worldwide with internal fertilization (Green and Campbell 1984). The sperm stays viable in the female's oviducts until egg laying in June or early July. Each female produces a double strand of 44–85 colourless, pea-sized eggs that she attaches to the underside of a large rock or bolder in the stream in late summer (Metter 1964; Nussbaum et al. 1983). Although eggs are difficult to find, previous studies have shown that eggs are generally found close to headwaters (Brown 1975; Adams 1993).

The embryos emerge approximately 6 weeks after the eggs are deposited. They feed on a yolk sac which sustains them through the winter in the natal pool until their suctorial mouth is fully developed, after which they become more mobile (Metter 1964; Brown 1975). The tadpole stage lasts between 2 to 4 years prior to metamorphosis (Metter 1964; Brown 1990). However, 1-year larval cycles have been observed for the Coastal Tailed Frog in northern California (Wallace and Diller 1998). Variation in the age at metamorphosis appears to reflect differences in climatic conditions throughout the species range (Bury and Adams 1999).

Home range

Home range is not known. A study on age-specific movement patterns of Rocky Mountain Tailed Frogs found that adults remain closely associated with their natal stream throughout their lives, often not moving more than 20 m per year and between years (Daugherty and Sheldon 1982). In the Coast Range, adults have been reported several hundred metres from a stream's edge during wet weather (Bury and Corn 1988; Dupuis et al. 1995; Gomez and Anthony 1996; Wahbe et al. 2000). Climatic conditions likely favourable for tailed frogs (e.g., high humidity, extended periods of rain) along the coast may enable adults to occupy larger home ranges or move longer distances.

Movements and dispersal

Data on movement and dispersal of Coastal Tailed Frogs for all life history stages are limited. Tadpoles are relatively sedentary but movements of up to 65 m have been recorded in old-growth streams in the Squamish area (Wahbe 1996). Given that eggs are generally deposited in the headwaters near the source of the stream (Brown 1975; Adams 1993), larval movement is thought to be primarily downstream (Wahbe et al. 2000). Tadpoles can be either nocturnal or diurnal, and may alter their behaviour to avoid detection by predators such as the Coast Giant Salamander (Feminella and Hawkins 1994).

Adults generally remain close to stream banks, and may move upstream either for refuge during the summer months or to lay eggs. A recent study in the Chilliwack Valley found Coastal Tailed Frogs in mature forests primarily within 5 m of the streamside, with a maximum distance of 45 m (Matsuda 2001). This study showed that, in clearcut sites, a higher proportion of frogs were caught at distances >45 m away, suggesting that frogs move beyond riparian zones in disturbed habitats when climatic conditions are favourable. A recent study in the Merritt area found only adult males or immature females on streams without larvae during September, which indicates that adult females are less likely to disperse during the breeding season (Gyug 2000).

Some evidence shows that newly metamorphosed tailed frogs represent the life history stage that migrates farthest away from the stream. Preliminary results from movement studies in the Squamish area found newly metamorphosed tailed frogs 100 m from the nearest stream during the fall (Wahbe et al. 2000). Bury and Corn (1987, 1988) also captured numerous recently metamorphosed tailed frogs in pitfall traps set in forested stands, in the fall.

Habitat

Structural stage

6: mature forest (100–140 years)
7: old forest (>140 years)

Important habitats and habitat features

The presence of intrusive or metamorphic bedrock formations, moderate annual rainfall with a relatively high proportion of it occurring during the summer, and watersheds with low or moderate previous levels of harvest appear to be large-scale regional features in predicting the presence of *Ascaphus* (Wilkins and Peterson 2000).

Terrestrial

Little work has been done on post-metamorphic and adult habitat associations. Coastal Tailed Frogs are more prone to desiccation than most anuran species due to their dependence on vascularized skin for respiration (Claussen 1973b).

Forested riparian areas can benefit tailed frog larvae by moderating stream and ambient temperatures. Forested buffers also help to maintain bank stability and channel characteristics (Kelsey 1995; Dupuis and Friele 1996; Dupuis and Steventon 1999).

Aquatic

The Coastal Tailed Frog inhabits mountain streams with step-pool morphologies, and overall gradients that are not too low or excessively steep (Dupuis et al. 2000). Larvae typically occur in creeks draining basins <50 km^2 but abundance is greatest in basins <10 km^2 (Dupuis and Friele 2003). Step-pools of cool, permanent streams adjacent to old forest with significant understorey are most suitable for this species. The species will also inhabit pool-riffle habitats characteristic of Coast Giant Salamander and fish-bearing streams.

Due to a long larval development period, tadpoles require stable perennial streams. Stable mountain streams are characterized by regularly spaced pools and interlocked cobble/boulder (or wood) steps that withstand moderate floods and sediment pulses (Chin 1998). Creeks composed of coarse substrates (boulders and large cobbles) and granodiorite bedrock that breaks down into coarse rock may maintain a higher density of tadpoles (Dupuis and Friele 1996; Diller and Wallace 1999). Coarse substrates allow for interstitial spaces that can serve as egg-laying and over-wintering sites, and cover in the event of flooding or small bedload movements. This is critical as tailed frogs have been shown to be negatively associated with the amount of fine sediments in streams (Bull and Carter 1996; Welsh and Ollivier 1998; Dupuis and Steventon 1999).

Tadpoles prefer smooth-surfaced substrates with a minimum diameter of 55 mm (Altig and Brodie 1972). Clear water is critical to allow for light penetration which stimulates algal growth, and also to minimize sedimentation which fills the interstitial spaces and results in scouring of periphyton from rocks. Tadpoles prefer rocks in turbulent water, and require interstitial spaces between rocks for both forage and cover (Altig and Brodie 1972). Juveniles and adults forage along the stream channel and in the riparian area and require riparian vegetation, boulders, and coarse woody debris for cover.

The creeks must remain cool throughout the summer as the species has a narrow temperature tolerance. However, at the northern limit of their range cold temperatures (<6°C) are considered limiting. The eggs require temperatures of 5–18°C to survive (Brown 1975). Stream temperatures and food resources during the growing season are probably the most important environmental variables influencing tadpole growth (Brown 1990).

Conservation and Management

Status

The Coastal Tailed Frog is on the provincial *Blue List* in British Columbia. It is designated as a species of *Special Concern* in Canada (COSEWIC 2002).

Summary of ABI status in BC and adjacent jurisdictions (NatureServe Explorer 2002)

BC	CA	OR	WA	Canada	Global
S3S4	S2S3	S3	S4	N3N4	G4

Trends

Population trends

The Coastal Tailed Frog is moderately widespread and locally common. Populations are remarkably discrete within streams. There is no estimated population size for the Coastal Tailed Frog in British Columbia. A recent study showed that Coastal Tailed Frogs occurred in 40–60% of creeks surveyed on the coast of British Columbia, but only 10% near the northern limit of the range (Dupuis et al. 2000).

Habitat trends

Headwater streams have historically been viewed as less important than salmonid streams, and have received little or no protection in British Columbia. Suitable habitat for the Coastal Tailed Frog is declining in British Columbia, particularly in areas that have been clearcut at higher elevations. According to Environment Canada's status report, about 75% of the tailed frog's habitat in British Columbia has been at least partially developed (Environment Canada 2001).

Threats

Population threats

Factors that contribute to the vulnerability of Coastal Tailed Frog populations include its specialized habitat requirements, long larval period, potentially limited dispersal capabilities, low reproductive rates, and low tolerance of warm temperatures. Tadpoles are vulnerable to local extirpations or population declines from massive bedload (boulders, logs, and debris) movements in the creeks. Survival to the adult stage appears to be particularly low in second-growth forests, which are predominant in its range.

Habitat threats

Coastal Tailed Frogs are habitat specialists and occur only in suitable mountain streams. Due to these specialized habitat requirements, the Coastal Tailed Frog is vulnerable to habitat loss and alteration associated with logging. Logging impacts include stream exposure (e.g., Holtby 1988), increased sedimentation (e.g., Beschta 1978; Reid and Dunne 1984), bank erosion (e.g., Beschta 1978), and windfall, as well as reduced summer flow rates and increased peak discharges (Jones and Grant 1996). Sedimentation fills the spaces between rocks, reducing the availability of refuge sites used to escape floods, bedload movements, predation, and warm temperatures. Large-scale habitat disturbance, loss, and fragmentation through road building and timber harvesting are also likely to be detrimental to the species.

Livestock grazing may impact stream habitats where livestock grazing occurs.

Legal Protection and Habitat Conservation

The Coastal Tailed Frog is protected, in that it cannot be killed, collected or held in captivity without special permits, under the provincial *Wildlife Act*. If salmonid habitat exists downstream, some level of protection may be provided through the *Fisheries Act*.

Some populations occur in provincial parks and ecological reserves, such as Cypress Provincial Park, Pinecone Burke Provincial Park, Cathedral Provincial Park, Mount Elphinstone, Garibaldi Provincial Park, and the Kitlope Heritage Conservancy.

The results based code may provide protection through the establishment of old growth management areas (OGMAs), provided these overlap with known sites or suitable habitat. In addition, riparian management guidelines provide a measure of protection for riparian habitats, particularly for streams with game fish. However, since most populations of the Coastal Tailed Frog are found in small streams without fish, they are not protected by FRPA riparian management recommendations. These recommendations do not recommend retention of a riparian reserve zone on small streams where "game" fish are not present. However, they do recommend that forest practices in management zones adjacent to streams classified as S4–S6 (small fish or non fish bearing) be planned and implemented to meet riparian objectives. These objectives can include retaining sufficient vegetation to provide shade, reduce microclimatic changes, maintain bank stability and, where specified, may include objectives for wildlife, fish habitat, channel stability, and downstream water quality.

Finally, some additional protection of Coastal Tailed Frog habitat may come through the creation of special resource management zones (SRMZs) and protected areas for other species, such as the Spotted Owl, and Grizzly Bear.

Identified Wildlife Provisions

Sustainable resource management and planning recommendations

In landscapes or portions of landscapes documented to contain tailed frog populations, consider the following recommendations:

- Establish OGMAs to protect known tailed frog occurrences and suitable riparian habitats (see "Important habitats and habitat features").

- Maximize connectivity of riparian habitats. Wherever possible, increase retention on streams classified as S5 or S6.
- Maintain water quality and flow characteristics (i.e., timing and quantity).
- Minimize use of chemical applications (e.g., dust-palliative polymer stabilizers and soil binders that can be sprayed within ditch lines).
- Avoid cross-stream yarding on suitable streams.

Wildlife habitat area

Goal

Maintain important streams and suitable breeding areas.

Feature

Establish WHAs on important streams and breeding areas. These streams/stream reaches are generally characterized by (1) presence of tadpoles, (2) year-round flow (perennial streams or gullies), (3) intermediate gradient (to allow formation of step-pool morphology), (4) coarse substrates, (5) stable channel beds, and (6) forest cover.

Size

Approximately 20 ha but will depend on site-specific factors including the number and length of stream reach included. Larger WHAs may be appropriate in watersheds with unstable terrain (class IV or V), or when WHAs are established to capture strategic metapopulations.

Design

A WHA should include at least two streams or stream reaches (e.g., S5 or S6) with evidence of presence of tailed frogs. The boundaries of a WHA should be designed to maintain stream conditions (substrate, temperature, macro-invertebrate, and algae communities). The WHA should include a 30 m core area and 20 m management zone on both sides or larger in areas of unstable terrain or to capture strategic metapopulations. Where slopes exceed 60%, the WHA should extend to the top of the inner gorge.

Where several streams with these characteristics occur, priority should be given to sites adjacent to mature or old forest, sites with the greatest potential to establish and maintain mature forest connectivity, sites closest to the headwaters, or sites with high density of tadpoles. In general, WHAs should be established in watersheds with low or moderate levels of historical harvest and on several streams/stream reaches in a drainage to ensure that at least one will maintain a viable subpopulation (Sutherland 2000).

General wildlife measures

Goals

1. Maintain clean and stable cobble/boulder gravel substrates, natural step-pool channel morphology, stream temperatures within tolerance limits.
2. Maintain microclimatic, hydrological, and sedimentation regimes to (1) limit the frequency of occurrence of extreme discharge events, (2) limit the mortality rate of tailed frogs during floods, and (3) meet foraging and dispersal requirements of the adults and metamorphs.
3. Maintain riparian forest.
4. Maintain important structural elements (e.g., coarse woody debris).
5. Maintain water quality and naturally dispersed water flows.
6. Minimize risk of windthrow.

Measures

Access

- Minimize roads or stream crossings within the core area. When roads are determined to be necessary, minimize length and construct narrow roads to minimize site disturbance and reduce groundwater interception in the cutslope; use sediment-control measures in cut-and-fill slopes (e.g., grass-seeding, armouring ditch lines, and culvert outfalls); deactivate roads but minimize digging and disturbance to adjacent roadside habitat; minimize site disturbance during harvesting, especially in terrain polygons with high sediment transfer potential to natal streams; and fall and yard away from, or bridging, all other stream channels (ephemeral or perennial) within the WHA, to reduce channel disturbance and slash loading.

- Where stream crossings are required, ensure the type of crossing structure and any associated roads are designed and installed in a way that minimizes impacts to tailed frog instream and riparian habitats. Use temporary clear span bridges where practicable.

Harvesting and silviculture

- Do not harvest in the core area. Use partial harvesting systems in the management zone that maintain 70% basal area with the appropriate structure necessary to achieve the goals of the GWM.
- Where management zones exceed 20 m, develop a management plan that is consistent with the goals of the GWM.
- No salvage should be carried out.
- Avoid cross-stream yarding.
- Do not use chemical applications (e.g., dust-palliative polymer stabilizers and soil binders that can be sprayed within ditch lines).

Pesticides

- Do not use pesticides.

Range

- Where livestock grazing occurs, follow recommended target conditions for range use in stream riparian areas. Fencing may be required by the statutory decision maker to ahcieve goals.

Additional Management Considerations

Wherever possible and practicable, augment management zone using wildlife tree retention areas.

Manage stream reaches adjacent to WHA according to riparian management recommendations.

Prevent fish introductions and rechannelization of areas supporting tailed frog populations.

Maintain slash-free headwater creeks and forested riparian buffers, especially within fragmented areas.

Information Needs

1. Age-specific movement and dispersal patterns and home range.
2. Demographic responses of Coastal Tailed Frogs to habitat change (e.g., age-class distribution, reproductive success, movement, and dispersal).
3. Opportunity to use variable retention and partial harvesting without degrading habitat suitability.

Cross References

Coastal Giant Salamander, Marbled Murrelet, Pacific Water Shrew

References Cited

Adams, M.J. 1993. Summer nests of the tailed frog (*Ascaphus truei*) from the Oregon Coast range. Northwest. Nat. 74: 15–18.

Altig, R. and E.D. Brodie, Jr. 1972. Laboratory behavior of *Ascaphus truei* tadpoles. J. Herpetol. 6(1):21–24.

Beschta, M. 1978. Long-term patterns of sediment production following road construction and logging in the Oregon Coast Range. Water Resour. Res. 14(6):1011–1016.

Brown, H.A. 1975. Temperature and development of the tailed frog, *Ascaphus truei*. Comp. Biochem. Physiol. 50A:397–405.

_____. 1989. Developmental anatomy of the tailed frog (*Ascaphus truei*): a primitive frog with large eggs and slow development. J. Zool. 55:343–348.

_____. 1990. Morphological variation and age-class determination in overwintering tadpoles of the tailed frog, *Ascaphus truei*. J. Zool. Lond. 220: 171–184.

Bull, E.L. and B.E. Carter. 1996. Tailed frogs: distribution, ecology, and association with timber harvest in northeastern Oregon. U.S. Dep. Agric. For. Serv., Res. Pap. (497):1–12.

Bury, R.B. and M.J. Adams. 1999. Variation in age at metamorphosis across a latitudinal gradient for the tailed frog, *Ascaphus truei*. Herpetologica 55(2):283–291.

Bury, R.B. and P.S. Corn. 1987. Evaluation of pitfall trapping in northwestern forests: trap arrays with drift fences. J. Wildl. Manage. 51:112–119.

_____. 1988. Responses of aquatic and streamside amphibians to timber harvest: a review. *In* Streamside management: riparian wildlife and forestry interactions. K.J. Raedeke (editor). Univ. Wash., Coll. For. Resour., Seattle, Wash., pp. 165–181.

Chin, A. 1998. On the stability of step-pool mountain streams. J. Geol. 106:59–69.

Claussen, D.L. 1973a. The thermal relations of the tailed frog, *Ascaphus truei*, and the Pacific treefrog, *Hyla regilla*. Comp. Biochem. Physiol. 44A:137–153.

_____. 1973b. The water relations of the tailed frog, *Ascaphus truei*, and the Pacific treefrog, *Hyla regilla*. Comp. Biochem. Physiol. 44A:155–171.

Committee on the Status of Endangered Wildlife in Canada (COSEWIC). 2002. Canadian Species at Risk. www.speciesatrisk.gc.ca

Corkran, C.C. and C.R. Thoms. 1996. Amphibians of Oregon, Washington and British Columbia. Lone Pine Publishing, Edmonton, Alta.

Daugherty, C.H. and A.L. Sheldon. 1982. Age-specific movement patterns of the frog *Ascaphus truei*. Herpetologica 38(4):468–474.

Diller, L.V. and R.L. Wallace. 1999. Distribution and habitat of *Ascaphus truei* in streams on managed, young growth forests in north coastal California. J. Herpetol. 33:71–79.

Dupuis, L.A. and F.L. Bunnell. 1997. Status and distribution of the Tailed Frog in British Columbia. Report for Forest Renewal BC. Univ. B.C., Cent. Appl. Conserv. Biol., Vancouver, B.C.

Dupuis, L.A., F.L. Bunnell, and P.A. Friele. 2000. Determinants of the tailed frog's range in British Columbia. Northwest Sci. 74:109–115.

Dupuis, L.A. and P.A. Friele. 1996. Riparian management and the tailed frog. Interim report prepared for B.C. Min. For., Prince Rupert For. Reg., Smithers, B.C. 18 p.

Dupuis, L.A. and P.A. Friele. 2003. Watershed-level protection and management measures for the maintenance of *Ascaphus truei* populations in the Skeena Region. Rep. prepared for B.C. Min. Water, Land and Air Protection, Smithers, B.C.

Dupuis, L.A., J.N.M. Smith, and F. Bunnell. 1995. Relation of terrestrial-breeding amphibian abundance to tree-stand age. Conserv. Biol. 9:645–653.

Dupuis, L.A. and D. Steventon. 1999. Riparian management and the tailed frog in northern coastal forests. For. Ecol. Manage. 124:35–43.

Environment Canada. 2001. Species at risk. Tailed frog: Pacific coast population. Available from: http://www.speciesatrisk.gc.ca/Species/.

Feminella, J.W. and C.P. Hawkins. 1994. Tailed frog tadpoles differentially alter their feeding behavior in response to non-visual cues from four predators. J. N. Am. Benthol. Soc. 13(2):310–320.

Gomez, D.M. and R.G. Anthony. 1996. Amphibian and reptile abundance in riparian and upslope areas of five forest types in western Oregon. Northwest Sci. 70:109–119.

Green, D.M. and R.W. Campbell. 1984. The amphibians of British Columbia. Royal B.C. Mus., Victoria, B.C. Handb. No. 45.

Green, D.M., T.F. Sharbel, R.A. Hitchmough, and C.H. Daugherty. 1989. Genetic variation in the genus *Leiopelma* and relationships to other primitive frogs. J. Zool. Syst. Evol. Res. 27(1989):65–79.

Gyug, L.W. 2000. Tailed frog inventory, year 2000, Merritt Forest District. Report prepared for B.C. Min. Environ., Lands and Parks, Southern Interior Reg., Kamloops, B.C. 33 p.

Holtby, L.B. 1988. Effects of logging on stream temperatures in Carnation Creek, British Columbia, and associated impacts on coho salmon (*Oncorhynchus kisutch*). Can. J. Fish. Aqua. Sci. 45:502–515.

Jamieson, B., M. Lee, and K. Long. 1993. Ultrastructure of the spermatozoon of the internally fertilizing frog *Ascaphus truei* (Ascaphidae: Anura: Amphibia) with phylogenetic considerations. Herpetologica 49(1):52–65.

Jones, J.A. and G.E. Grant. 1996. Peak flow responses to clearcutting and roads in small and large basins, western Cascades Oregon. Water Resour. Res. 32(4):959–974.

Kelsey, K.A. 1995. Responses of headwater stream amphibians to forest practices in Western Washington. Ph.D. thesis. Univ. Wash., Seattle, Wash. Unpubl.

Lamberti, G.A., S.V. Gregory, C.P. Hawkins, R.C. Wildman, L.R. Ashkenas, and D.M. Denicola. 1992. Plant-herbivore interactions in streams near Mount St. Helens. Freshwater Biol. 27:237–247.

Matsuda, B.M. 2001. The effects of clearcut timber harvest on the movement patterns of tailed frogs (*Ascaphus truei*) in southwestern British Columbia. M.Sc. thesis. Univ. B.C., Vancouver, B.C.

Metter, D.E. 1964. A morphological and ecological comparison of two populations of the tailed frog *Ascaphus truei* Stejneger. Copeia 1964:181–195.

Metter, D.E. 1967. Variation in the ribbed frog *Ascaphus truei* Stejneger. Copeia 1967:634–649.

NatureServe Explorer. 2002. An online encyclopaedia of life. Version 1.6. NatureServe. Arlington, VA. Available at http://www.natureserve.org/explorer/

Nielson, M., K. Lohman, and J. Sullivan. 2001. Phylogeography of the Tailed Frog (*Ascaphus truei*): implications for the biogeography of the Pacific Northwest. Evolution 55(1):147–160.

Nussbaum, R.A., E.D. Brodie, Jr., and R.M. Storm. 1983. Amphibians and reptiles of the Pacific Northwest. Univ. Idaho Press, Moscow, Idaho. 332 p.

Reid, L.M. and T. Dunne. 1984. Sediment production from forest road surfaces. Water Resour. Res. 20:1753–1761.

Ritland, K., L.A. Dupuis, F.L. Bunnell, W.L.Y. Hung, and J.E. Carlson. 2000. Phylogeography of the tailed frog (*Ascaphus truei*) in British Columbia. Can. J. Zool. 78:1749–1758.

Sutherland, G.D. 2000. Risk assessment for conservation under ecological uncertainty: a case study with a stream-dwelling amphibian in managed forests. Ph.D. thesis. Univ. B.C., Vancouver, B.C. 154 p.

Wahbe, T.R. 1996. Tailed frogs (*Ascaphus truei* Stejneger) in natural and managed coastal temperate rainforests of southwestern British Columbia, Canada. M.Sc. thesis. Univ. B.C., Vancouver, B.C. 49 p.

Wahbe, T.R., F.L. Bunnell, and R.B. Bury. 2000. Defining wildlife habitat areas for tailed frogs. *In* Proc. Conf. on the biology and management of species and habitats at risk. L.M. Darling (editor). Kamloops, B.C., Feb. 15–19, 1999. B.C. Min. Environ., Lands and Parks, Victoria, B.C., and Univ. Coll. Cariboo, Kamloops, B.C., pp. 489–496.

Wallace, R.L. and L.V. Diller. 1998. Length of the larval cycle of *Ascaphus truei* in coastal streams of the Redwood Region, Northern California. J. Herpetol. 32(3):404–409.

Welsh, H.H., Jr. and L.M. Ollivier. 1998. Stream amphibians as indicators of ecosystem stress: a case study from California's redwoods. Ecol. Appl. 8(4):1118–1132.

Wilkins, R.N. and N.P. Peterson. 2000. Factors related to amphibian occurrence and abundance in headwater streams draining second-growth Douglas-fir forests in southwestern Washington. Forest Ecology and Manage. 139:79–91.

Personal Communications

Dupuis, L.A. 2002. Consultant, Squamish, B.C.

COEUR D'ALENE SALAMANDER

Plethodon idahoensis

Original prepared by I.A. (Penny) Ohanjanian

Species Information

Taxonomy

The Coeur d'Alene Salamander is in the Plethodontidae family (lungless salamanders). Until recently, the Coeur d'Alene Salamander was considered by some authors to be a subspecies of Van Dyke's salamander (*Plethodon vandykei*) (Nussbaum et al. 1983). Recent genetic work and morphometric analysis, however, have confirmed that *P. idahoensis* is a distinct species (Howard et al. 1993; Wilson and Larsen 1999). There are no recognized subspecies.

Description

The Coeur d'Alene Salamander is a lungless, terrestrial salamander. They are blackish brown, with a yellowish throat patch and a yellow, orange, or mustard-coloured dorsal stripe with irregular margins. Occasionally, individuals with a reddish stripe are encountered. Females are larger than males (Lynch 1984) and may reach up to 130 mm in total length, with snout-vent lengths reaching 65 mm (Ohanjanian 2000a). Coeur d'Alene Salamanders have distinct parotoid glands at the rear of the head (Nussbaum et al. 1983), long legs, and short, slightly webbed toes (Cassirer et al. 1994).

Distribution

Global

The known distribution of the Coeur d'Alene Salamander is fragmented. Isolated populations are scattered throughout northern Idaho, western Montana, and southeastern British Columbia (Cassirer et al. 1994; Wilson et al. 1989, 1997).

British Columbia

Coeur d'Alene Salamanders are distributed in tributaries and seepages that drain into Moyie River, Duck Lake, Kootenay Lake, the Duncan Reservoir, Lower and Upper Arrow lakes, and St. Mary's River (Ohanjanian 1997a, 1998, 2000b; Dulisse 1999; L. Amos, pers. comm.). The species has recently (2001) been confirmed near Revelstoke, thereby extending the northern limits of its range by 120 km. In addition, this species has been confirmed in the West Kootenays (Kimberley and Cranbrook areas) (Ohanjanian, unpubl. data).

Forest region and districts

Southern Interior: Arrow Boundary, Columbia, Kootenay Lake, Rocky Mountain

Ecoprovinces and ecosections

SIM: CCM, MCR, SCM, SFH, SPM

Biogeoclimatic units

ICH: dw, mk1 (in MCR), mw2 (in CCM and SFH), wk1 (in CCM), xw (in SCM and SFH),
IDF: un (SFH)
MS: dk

Broad ecosystem units

AV, RO, SP (DP, DF, IH on steep south-facing slopes associated with talus habitats)

Elevation

500–1550 m (Groves et al. 1996; Wilson et al. 1997)

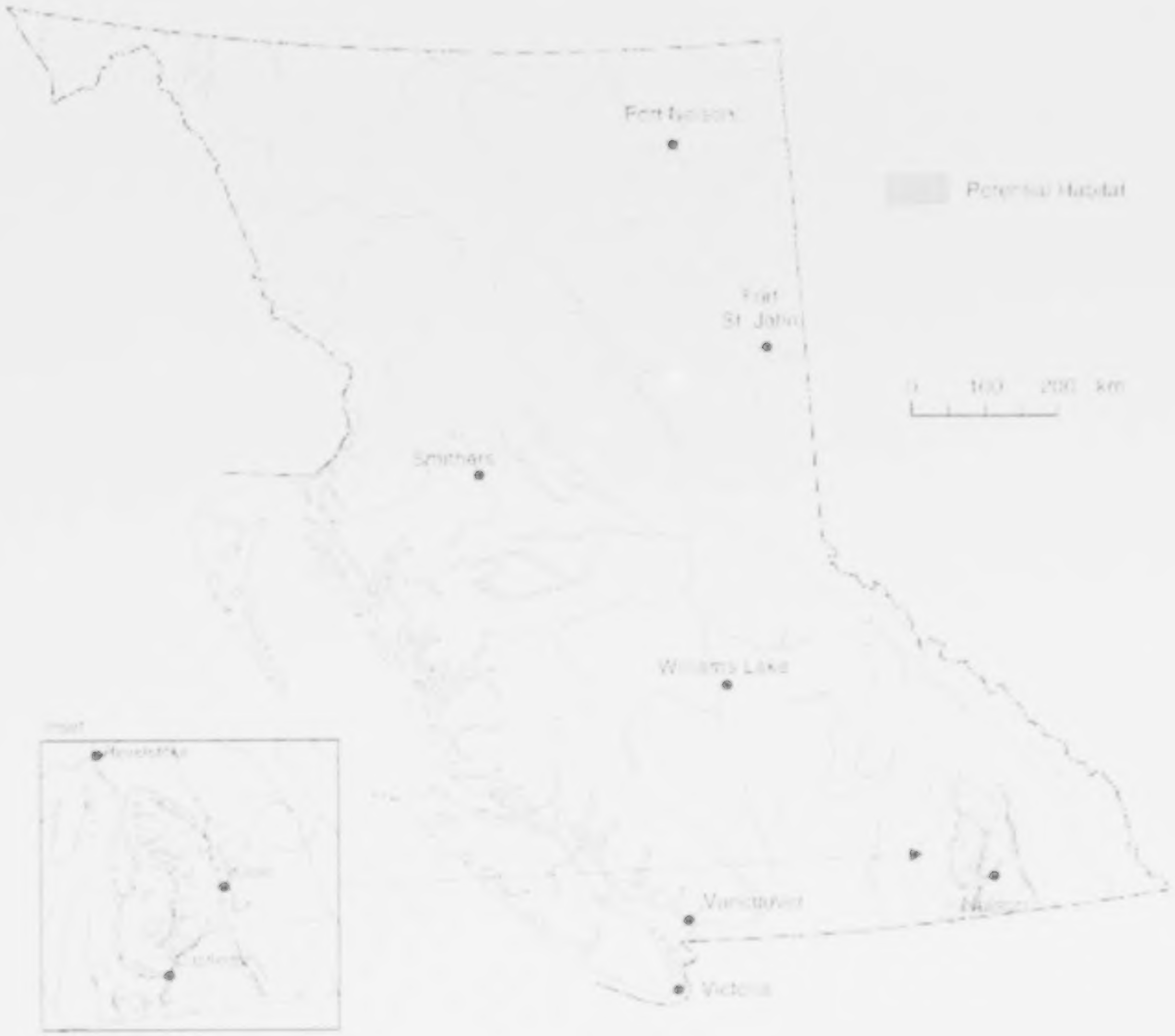
Life History

Diet and foraging behaviour

Coeur d'Alene Salamanders are nocturnal, and feed primarily on insects (Wilson and Larsen 1988). They

Coeur d'Alene Salamander

(Plethodon idahoensis)


Fort Nelson
Potential Habitat
Fort St. John
0 100 200 km
Smithers
Williams Lake
Inset
Revelstoke
Nelson
Castlegar
Vancouver
Nelson
Victoria

Note: This map represents a broad view of the distribution of potential habitat used by this species. The map is based on several ecosystem classifications (Ecoregion, Biogeoclimatic and Broad Ecosystem units) as well as current knowledge of the species' habitat preferences. This species may or may not occur in all areas indicated. Recent records (2001, 2002) not included.

forage on the surface during wet periods in spring, summer and fall within suitable habitats (moist areas), usually near subsurface retreats, but they may, under optimal conditions, travel farther (Cassirer et al. 1994).

Reproduction

Mating occurs primarily in the late summer and fall but may also occur in the spring. Young hatch in early fall directly from eggs. There is no larval stage. Female Coeur d'Alene Salamanders lay eggs *only* in alternate years and are not reproductive until they are 4 years old (Lynch 1984).

Site fidelity

There is no information on movements of Coeur d'Alene Salamanders from site to site. Certain individuals appear to remain under specific cover objects at a site, but this is not consistent (Ohanjanian 2000a).

Home range

Home range size has not yet been determined; however, one individual is known to have moved at least 31 m over 14 days, and another was detected on a rainy night 50 m away from a waterfall area (Ohanjanian 1997b, 2000a).

Movements and dispersal

Although these salamanders spend much of the year in subsurface retreats, they are active above ground during the spring and fall (May through October) or during wet periods in the summer. During this time they will forage, mate, and disperse.

Since plethodontid salamanders require a damp environment for respiration and rehydration (Spotila 1972), and parts of their range in British Columbia are characterized by a dry, severe climate (Braumandl and Curran 1992), opportunities to disperse are likely poor and must coincide with relatively rare periods of extended rainfall. Some dispersal may occur on an elevational gradient, as they have been found at more than one location on a given watercourse (Ohanjanian 1998).

Habitat

Structural stage

3b: tall shrub
4: pole sapling
5: young forest
6: mature forest
7: old forest

Important habitats and habitat features

This species has highly specialized habitat requirements (Cassirer et al. 1994). A damp environment is essential for respiration and rehydration. Generally, Coeur d'Alene Salamanders occur in wet microhabitats associated with fissured bedrock or deep, wet talus (Cassirer et al. 1994; Ohanjanian 1997a). They require moist underground rocky retreats to avoid desiccation in summer and freezing in winter. Important habitat features with these characteristics include waterfall splash zones; rock seepages; fissured bedrock in association with streams; and deep, wet, talus. Occupied watercourses vary in size and individuals have been found on rock walls where surficial water is present for only a part of the year (Ohanjanian 1997b).

Suitable habitat generally occurs in areas of steep topography where bedrock is near the surface. Areas overlain with unconsolidated glacial or alluvial deposits do not provide underground habitat for Coeur d'Alene Salamanders and these features may limit their distribution (Wilson and Larsen 1998).

In spring, summer, and fall, rock slabs, moist cracks in bedrock, deep moss, and coarse woody debris in the wetted areas of streams provide seasonal cover near the surface. However, when it is dry or cold, Coeur d'Alene Salamanders must be able to retreat deep into bedrock or talus.

Overstorey vegetation in forested areas adjacent to rocky retreats and streams reduces evaporation caused by incident solar radiation and raises the humidity of the substrate. Minimum canopy cover at stream sites in the United States was 42% with a mean of 83% ± 15% (Cassirer et al. 1994). At seepage sites, this mean is lower (57% ± 5%), probably because the terrain is often near vertical at seepages. The forests between streams and seepages provide the Coeur d'Alene Salamander with additional opportunities for foraging and may allow the dispersal of juveniles from one watercourse to another during prolonged rain events.

Conservation and Management

Status

The Coeur d'Alene Salamander is on the provincial *Blue List* in British Columbia. It is considered a species of *Special Concern* in Canada (COSEWIC 2002).

Summary of ABI status in BC and adjacent jurisdictions (NatureServe Explorer 2002)

BC	ID	MT	Canada	Global
S3	S3	S2	N3	G4

Trends

Population trends

In British Columbia, the Coeur d'Alene Salamander is known from 44 sites on 41 distinct watercourses in 16 localities. Although no data are available on absolute abundance or trends, populations are likely small, as encounter rates seem low when compared with some sites in the Unites States (Ohanjanian 1997a).

Habitat trends

As the human population increases, more water may be diverted from streams for community watersheds. Ongoing road construction may also reduce habitat availability.

Threats

Population threats

In addition to being small, populations also tend to be "scarce and clustered" and some are likely isolated (Dupuis and Ohanjanian 1997). This species' limited dispersal ability and sensitivity to desiccation may impede genetic exchange or recolonization of sites. In addition, its low reproductive rate makes it difficult for populations to recover should habitat loss, disturbance, or direct mortality cause it to decline. Thus, it may be vulnerable to local extirpations.

Habitat threats

The greatest threat to this species' habitat is the alteration of the hydrology of occupied wet microhabitats (i.e., fissured bedrock or deep, wet talus, and associated foraging habitat). The main activities that are likely to result in changes to the hydrology of known Coeur d'Alene Salamander sites are forest management and road development (Cannings et al. 1999). If climate change results in lower precipitation or decreases in snowpack, populations associated with seepages and low volume creeks will likely dry out and be extirpated. Blasting for road maintenance or widening can also eliminate populations (Ohanjanian 1997a, 1997b; A.G. Wilson, pers. comm.)

Alterations in hydrology include upslope water diversion (may desiccate downslope habitat), loss of overstorey vegetation (decreases substrate moisture and therefore reduces foraging opportunities or prevents movement of salamanders between sites), and flooding from increases in peak flows. Populations that occupy seepages flowing along rock faces may be particularly vulnerable to decreases in flow caused upslope, as many of these sites have low flow for much of the year.

Structural changes to the habitat may also threaten Coeur d'Alene Salamanders. These include sedimentation or slumping, which may clog salamander retreats; blasting of rock for road construction, or culvert construction, which may directly kill salamanders; and silvicultural practices such as herbicide application and burning, which alter vegetative structure, abundance of coarse woody debris, and the invertebrate prey base. Operation of heavy equipment and cross-stream yarding may directly kill salamanders and destroy their cover objects.

Legal Protection and Habitat Conservation

The Coeur d'Alene Salamander is protected, in that it cannot be killed, collected, or held in captivity without special permits, under the provincial *Wildlife Act*.

Of the 44 known occurrences, one is in a provincial park, three are in proposed Goal 2 Protected Areas, and one is in a Ministry of Forests recreation site. The remaining occurrences are on private land, highway right-of-ways, or Crown land.

The greatest protection the Crown land sites can receive, under the results based code, is the Best Management Practices for S2 and S3 streams. These practices recommend a "no logging" reserve zone (30 and 20 m wide, respectively) as well as a 20 m management zone. Guidelines for smaller streams (i.e., S4, S5, and S6) do not adequately protect Coeur d'Alene Salamanders. Ephemeral rock seepages are not protected under the results based code. Some sites may be established as wildlife habitat features under the results based code.

Identified Wildlife Provisions

Sustainable resource management and planning recommendations

- Maintain hydrological characteristics (surface and subsurface) of slopes above and/or influencing downstream hydrology and micro- and macro-drainage patterns of streams and seepages within the range of the Coeur d'Alene Salamander.
- Maximize connectivity between known occurrences and suitable habitat (wet talus and fissured bedrock associated with water below 1550 m within the range of the Coeur d'Alene Salamander). Riparian connectivity and/or forested habitat in addition to underground passages are expected to provide the principal dispersal avenues for juveniles.
- Wherever possible, increase forest retention on stream reaches adjacent to WHAs.
- Avoid activities that affect the hydrology, microclimate, or rock structure, particularly blasting, between neighbouring occurrences.

Wildlife habitat area

Goal

Protect populations by maintaining the structural and hydrological integrity of known subsurface retreats and adjacent above-surface foraging and breeding habitat (adjacent forested areas).

Feature

Establish WHAs at known occurrences within natural habitats. Use the wildlife habitat feature designation to address occurrences within human-made habitats (i.e., road structures).

Size

Typically, <20 ha; however, the size will be based on the extent of suitable habitat, microclimate, and hydrological considerations.

Design

The WHA should consist of a core area plus a 20–40 m management zone. The core area should be delineated to include all suitable habitat (i.e., wet, fissured bedrock or deep wet talus) plus adjacent suitable foraging habitat (i.e., forested habitat within 50 m of the wet bedrock or talus). The management zone should be designed to protect the windfirmness and microclimate of the core area.

General wildlife measures

Goals

1. Maintain microhabitat conditions by ensuring streamside moisture levels and natural flow regimes of watercourses are unaltered.
2. Ensure that the integrity of structural habitat (fissured bedrock and/or talus) remains intact and is protected from destruction by blasting or siltation.
3. Protect population from physical disturbance and direct mortality.
4. Prevent compaction of interstitial spaces.
5. Ensure WHA boundaries are windfirm.

Measures

Access

- Do not construct roads unless there is no other practicable option. When roads are determined to be necessary, locate downslope from the WHA to prevent siltation. If roads must be built upslope, ensure every measure is taken to prevent water diversion, which can lead to desiccation of habitat downslope.
- Do not build stream crossings unless there is no other practicable option. Where crossings are determined to be necessary, use open-bottomed structures (e.g., bridges or log culverts). Ensure adequate silt and sediment control measures are implemented.
- Do not remove rock or talus.

Harvesting and silviculture

- In core area, do not harvest or salvage, except when there are serious forest health concerns and disturbance to aquatic habitats are minimized.
- Do not harvest within management zone between 1 May to 30 October. Up to 30% basal area or greater, where topographic shading dominates the microsite, may be removed in the management zone to create a windfirm boundary zone and maintain the microclimatic conditions of the core area.
- Leave wildlife trees, deciduous trees, and shrubs in the management zone.
- Leave coarse woody debris, moss, and understorey intact.
- Do not disturb substrate.
- Burning should not be carried out in the management zone or core area.

Pesticides

- Do not use pesticides.

Recreation

- Do not establish recreation sites.

Additional Management Considerations

Apply best management practices, according to riparian management recommendations, on streams where Coeur d'Alene Salamanders are present.

Information Needs

1. Movement and distribution along creeks.
2. Information on species' occurrence on eastern slopes of Purcell Mountains (near Kimberley).
3. Dispersal and ability to move between sites.

Cross References

Rocky Mountain Tailed Frog

References Cited

Braumandl, T.F. and M.P. Curran. 1992. A field guide for site identification and interpretation for the Nelson Forest Region. B.C. Min. For., Nelson For. Reg., Nelson, B.C.

Cannings, S.G., L.R. Ramsay, D.F. Fraser, and M.A. Fraker. 1999. Rare amphibians, reptiles and mammals of British Columbia. B.C. Min. Environ., Lands and Parks, Wildl. Br. and Resour. Inv. Br., Victoria, B.C. 198 p.

Cassirer, E.E., C.R. Groves, and D.L. Genter. 1994. Coeur d'Alene Salamander conservation assessment. U.S. Dep. Agric. For. Serv. Reg. 1, Missoula, Mont.

Committee on the Status of Endangered Wildlife in Canada (COSEWIC). 2002. Canadian Species at Risk. www.speciesatrisk.gc.ca

Dulisse, J. 1999. Syringa Creek Provincial Park rare and endangered species evaluation. Report to BC Parks. 25 p.

Dupuis, L.A. and P. Ohanjanian. 1997. Status report on the salamander, *Plethodon idahoensis,* in Canada. Committee on the Status of Endangered Wildlife in Canada, Ottawa, Ont.

Groves, C.R., E.E. Cassirer, D.L. Genter, and J.D. Reichel. 1996. Coeur d'Alene salamander (*Plethodon idahoensis*). Nat. Areas J. 16(3):238–247.

Howard, J.H., L.W. Seeb, and R. Wallace. 1993. Genetic variation and population divergence in the *Plethodon vandykei* species group (Caudata: Plethodontidae). Herpetologica 49:238–247.

Lynch, J.E. Jr. 1984. Reproductive ecology of *Plethodon idahoensis.* M.Sc. thesis. Univ. Idaho, Moscow, Idaho. 59 p.

NatureServe Explorer. 2002. An online encyclopaedia of life. Version 1.6. NatureServe. Arlington, VA. Available at http://www.natureserve.org/explorer/

Nussbaum, R.A., E.D. Brodie, Jr., and R.M. Storm. 1983. Amphibians and reptiles of the Pacific Northwest. Univ. Idaho Press, Moscow, Idaho. 332 p.

Ohanjanian, I.A. 1997a. The Coeur d'Alene salamander (*Plethodon idahoensis*) in southeastern British Columbia. Report to BC Environ., Nelson, B.C.

_____. 1997b. Confidential folio of *P. idahoensis* occurrences in southeastern British Columbia: Detailed locational information, survey results and site-specific risk assessments and recommendations. BC Environ., Nelson, B.C.

_____. 1998. Coeur d'Alene Salamander inventory. Report to Wynndel Box and Lumber Co. Ltd., BC Environ., and Forest Renewal BC.

_____. 2000a. The Coeur d'Alene Salamander (*Plethodon idahoensis*) in the operating area of Wynndel Box and Lumber Co. Ltd., additional inventory information and preliminary population studies. Report prepared for Wynndel Box and Lumber Co. Ltd., Forest Renewal BC, and B.C. Min. Environ., Lands and Parks. 39 p.

_____. 2000b. The Coeur d'Alene Salamander (*Plethodon idahoensis*) distribution in the Kootenay Lake and Arrow Forest Districts. Report to B.C. Min. Environ., Lands and Parks, and Habitat Conserv. Trust Fund. In prep.

Spotila, J.R. 1972. Role of temperature and water in the ecology of lungless salamanders. Ecol. Monogr. 42:95–125.

Wilson, A.G., Jr. and J.H. Larsen, Jr. 1988. Activity and diet in seepage-dwelling Coeur d'Alene salamanders (*Plethodon vandykei idahoensis*). Northwest Sci. 62(5):211–217.

_____. 1999. Morphometric analysis of salamanders of the *Plethodon vandykei* species group. Am. Midland Nat. 141:266–276.

Wilson, A.G., Jr., E. Simon, Jr., and J.H. Larson, Jr. 1989. Range extension for the Coeur d'Alene salamander, *Plethodon vandykei idahoensis*, to the Canada–United States border. Can. Field-Nat. 103:93–94.

Wilson, A.G., Jr., E.M. Wilson, C.R. Groves, and R.L. Wallace. 1997. U.S. distribution of the Coeur d'Alene salamander (*Plethodon idahoensis* Slater and Slipp). Great Basin Nat. 57(4):359–362.

Personal Communications

Amos, L. 2001. Interior Reforestation Ltd., Cranbrook, B.C.

Wilson, A.G., Jr. 2000. Spokane Falls Community College, Spokane, Wash.

GREAT BASIN SPADEFOOT

Spea intermontana

Original prepared by Mike Sarell

Species Information

Taxonomy

The Great Basin Spadefoot, *Spea intermontana*, belongs to the family Pelobatidae (spadefoots) and is the only species in the *Spea* genera in British Columbia. Until recently, the Great Basin Spadefoot was placed in the genus *Scaphiopus*. Although there are no currently recognized subspecies (Green 1999), the variation between populations of *Spea intermontana* may represent separate species (Wiens and Titus 1991).

Description

The Great Basin Spadefoot is the only spadefoot toad in British Columbia. It is a small anuran (40–64 mm svl) that differs from true toads (genus *Bufo*) by having vertical pupils, no (or indistinct) parotid glands, and relatively smooth skin. It has well-developed, sharp-edged black tubercals or "spades" on the bottom of each hind foot, which are used for burrowing. The ventral surface is cream coloured or white whereas the dorsal surface may be olive or grey with spots or streaks. Tadpoles are heavy bodied, grey or tan with brass flecks. Other tadpole characteristics include prominent nostrils close to the eyes, and eyes that are close together and somewhat upturned (Corkran and Thoms 1996).

Distribution

Global

The Great Basin Spadefoot occurs from southern British Columbia, south through the Great Basin to California, Arizona, and east to Colorado and Wyoming (Green 1999). In Canada, it occurs only in British Columbia.

British Columbia

In British Columbia, it occurs in the Okanagan, Similkameen, Kettle, Nicola, and Thompson valleys north to 70 Mile House in the Cariboo, west to Princeton, and east to Grand Forks. In addition to climate, the range of this species is related to the distribution of deep friable soils and wetlands. Their range also may be correlated with the range of pocket gophers (*Thomomys* spp.) and other small mammals due to loosening of compact morainal soils.

Forest region and districts

Southern Interior: 100 Mile House, Arrow Boundary, Cascades, Central Cariboo, Kamloops, Okanagan Shuswap

Ecoprovinces and ecosections

CEI: CAB, CAP*[1], CHP*, FRB*
SIM: SFH*
SOI: NOB, NOH, NTU, OKR, PAR*, SHB, SOB, SOH, STU, THB, TRU

Biogeoclimatic units

BG: xh1, xh2, xh3, xw, xw1, xw2
ESSF: dc*
ICH: dw*, mk*, xw
IDF: dm1, dk1, dk2, mw1*, mw2*, xh1, xh1a, xh2, xh2a, xw
MS: dm*
PP: dh1, xh1, xh2

Broad ecosystem units

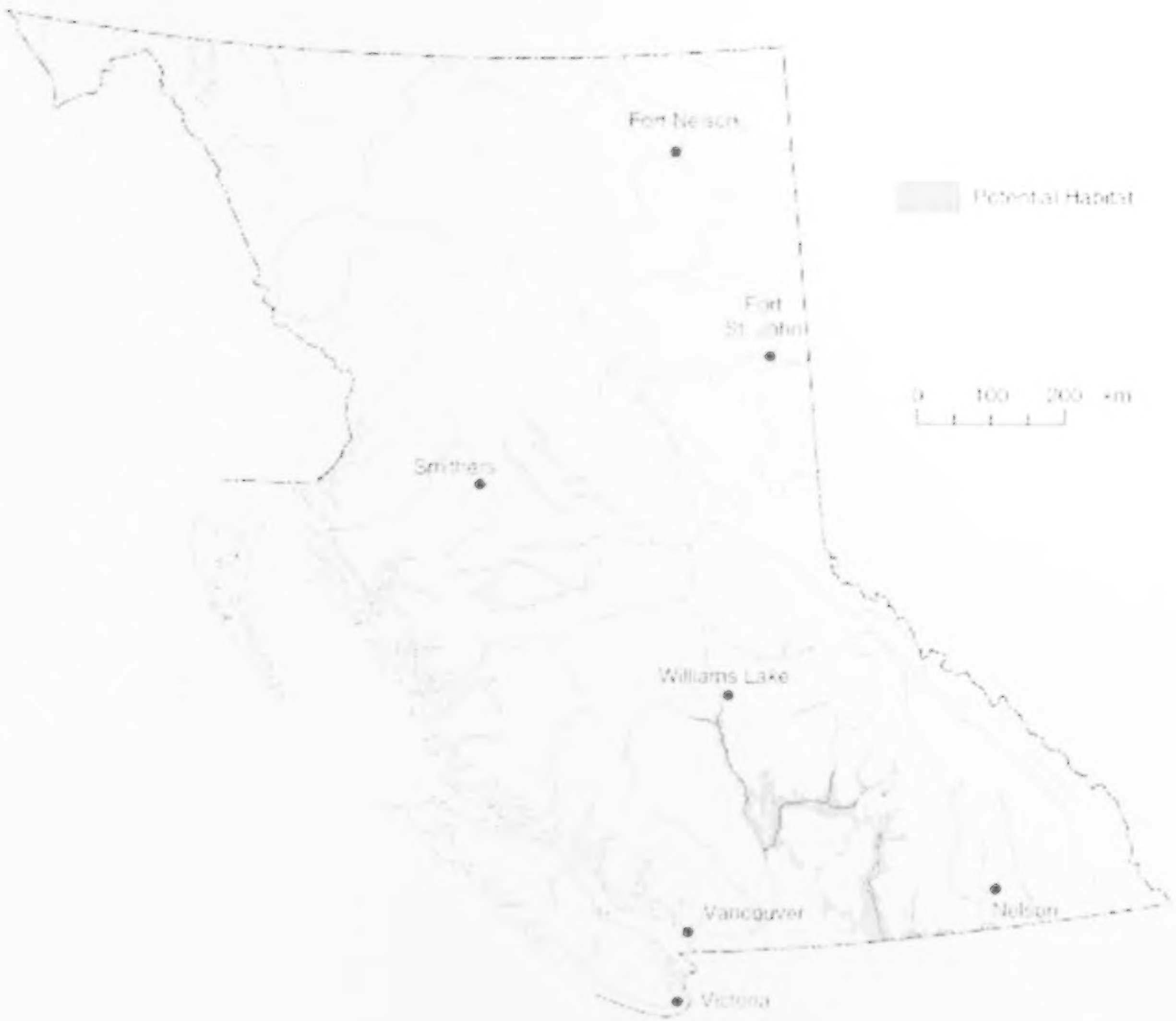
Terrestrial: AB, BS, DF, DP, OV, PP, SS
Aquatic: GB, LS, SP

---

[1] * Indicates that range extent has not been confirmed.

Great Basin Spadefoot

(Spea intermontana)


Fort Nelson
Potential Habitat
Fort St. John
0 100 200 km
Smithers
Williams Lake
Vancouver
Nelson
Victoria

Note: This map represents a broad view of the distribution of potential habitat used by this species. The map is based on several ecosystem classifications (Ecoregion, Biogeoclimatic and Broad Ecosystem Inventory) as well as current knowledge of the species' habitat preferences. This species may or may not occur in all areas indicated.

Elevation

275–1800 m but generally found breeding below 600 m (St. John 1993; Cannings 1998)

Life History

Diet and foraging behaviour

Adult spadefoots are insectivorous and prey on a variety of invertebrates including earthworms, ants, beetles, crickets, and flies (Nussbaum et al. 1983). Aquatic larvae feed on algae, aquatic plants, or detritus (Green and Campbell 1984). Adult Great Basin Spadefoots forage at night, particularly under warm (>12°C), wet conditions. The remainder of the time is spent inactive, in underground retreats.

Reproduction

The Great Basin Spadefoot reaches sexual maturity at 2–3 years of age. Adults emerge from overwintering sites in mid-April and migrate to aquatic breeding sites. Females deposit eggs from April to early June. Between 300 and 800 eggs are deposited, in clusters of 20–40 eggs, which are fertilized externally. Eggs are normally deposited under the water surface on submerged vegetation or the bottom of pools. Eggs and tadpoles develop relatively rapidly which enables the Great Basin Spadefoot to successfully breed in aquatic habitats that are only available seasonally for short periods before drying up. Tadpoles also exhibit a tolerance to very warm water temperatures (Low 1976). Eggs generally hatch within a week, depending on water temperature, and tadpoles transform in 6–8 weeks. Metamorphosed spadefoots often still have a substantial tail when they leave the water (Nussbaum et al. 1983). The length of the breeding season varies considerably between sites (St. John 1993), but most metamorphosed toadlets appear in July (Cannings 1998).

Site fidelity

Site fidelity to breeding ponds has not been documented. It is assumed that spadefoots will use the nearest available water source, as many breeding sites are ephemeral and not always suitable. It is not known how far spadefoots can successfully travel to a breeding site.

Home range

The distance adult spadefoots will travel from breeding sites has not been documented, and is difficult to determine as some breeding sites are inconspicuous, particularly if they are suitable for breeding only in some years. The nocturnal habits and burrowing nature of the adults also makes it difficult to locate them in foraging areas.

Movements and dispersal

The Great Basin Spadefoot generally migrates to aquatic breeding habitats after the first warm rainfall in the spring. Although information on dispersal distances is lacking, spadefoots may migrate several hundred metres between aquatic breeding sites and terrestrial non-breeding habitats, and some may travel much farther. There are two emigration movements: after adults breed and after young metamorphose.

Habitat

Structural stage

Although most closely associated with herb (2) and shrub (3) structural stages for foraging, they will occur in open forest (4–7). Soil texture and depth, and an open habitat structure are more critical factors in determining foraging suitability.

Important habitats and habitat features

Aquatic

The Great Basin Spadefoot breeds in permanent or temporary aquatic habitats such as lakes, seasonal wetlands, rain pools, flooded areas along streams, and pools in intermittent streams. Shallow water is an important feature of suitable breeding sites, including the edges of deeper water features. Emergent vegetation aids in breeding as a substrate for egg deposition but is not essential. The absence of predatory fish dramatically increases the survival of eggs and tadpoles. Breeding habitat is used between April and July.

Terrestrial

Spadefoots occur in semi-arid habitats such as bunchgrass grasslands, sagebrush steppe, and open ponderosa pine (*Pinus ponderosa*) forests. They escape dry conditions by retreating into underground refuges such as small mammal burrows or by burrowing into the soil. Loose and deep soils provide suitable burrowing habitat. They may also retreat under coarse woody materials. It is unknown how deep the burrows must be to avoid lethal temperatures during winter hibernation, but may be up to 1 m or more. Terrestrial habitats are used throughout the year.

Conservation and Management

Status

The Great Basin Spadefoot is on the provincial *Blue List* in British Columbia. It is considered *Threatened* in Canada (COSEWIC 2002).

Summary of status in British Columbia and adjacent jurisdictions (NatureServe Explorer 2002)

BC	CA	CO	ID	MT	WA	Canada	Global
S3	S5	S3	S4	SR	S5	N3	G5

Trends

Population trends

Only three detailed population surveys have been conducted in British Columbia (St. John 1993; Leupin et al. 1994; Weber 1996), all in the south Okanagan or Thompson and Nicola valleys. The population is estimated to be approximately 10 000 (Cannings 1998); however, trends are not known (Cannings et al. 1999). The population in British Columbia has been described as "clumped" because over half of the calling males are reported from only three sites (Cannings 1998). The largest populations in the Okanagan are at Osoyoos Oxbows and Osoyoos Effluent Lagoon (St. John 1993).

Habitat trends

Most of the spadefoot population occurs in the arid grasslands in the valley bottoms of the Okanagan, Similkameen, Kettle, Nicola, and Thompson watersheds. These habitats, especially the Okanagan, are under intense development pressure. It was estimated that <9% of the south Okanagan remains in a relatively natural state (Redpath 1990). Agricultural and residential developments have already altered much of their former habitat. Most of the remaining habitats throughout their range are roaded or used for grazing, and much is weeded.

The largest known population of Great Basin Spadefoot occurs at the Osoyoos sewage lagoon (St. John 1993), where much of the surrounding antelope-brush and sagebrush grasslands have been recently lost to housing and golf course expansion.

Threats

Population threats

The range of the Great Basin Spadefoot in British Columbia tends to be concentrated in the valley bottoms, where the demand for agricultural and residential land is high. Because the distribution appears to be clumped, populations may be more susceptible to local extirpation if these areas are disturbed.

There are no known disease or infection threats, although at least one die-off of Tiger Salamanders (*Ambystoma tigrinum*) has occurred in the south Okanagan, for unknown reasons. These species are sympatric in breeding habitats within the salamander's range.

The water table at many sites within the range of the Great Basin Spadefoot has dropped significantly in the past decades, due to reduced precipitation and possibly increased human consumption (Cannings 1998). Although spadefoot eggs and tadpoles develop quickly, shorter breeding periods due to drying ponds likely reduce breeding success, and may prevent it altogether in dry years. If permanent or ephemeral breeding sites were to dry up, spadefoots would become increasingly dependent on fish-bearing and artificial or managed water bodies.

In permanent water bodies, non-native species, especially various species of non-native predatory fish, are a threat. Bullfrogs (*Rana catesbeiana*) have not successfully colonized spadefoot breeding habitat yet but have been the cause of significant declines elsewhere. In terrestrial habitats, the invasion of non-native plants may affect the available invertebrate composition and may hinder burrowing due to continuous root mats.

Although nothing is known about the specific effect on Great Basin Spadefoots, amphibians are known to be highly susceptible to environmental contaminants and changes (Seburn and Seburn 2000). Water quality of breeding sites may be affected by pollution from pesticides, dumping refuse to fill wetlands, and runoff from accumulated livestock faeces.

High mortality from road kill occurs at some migration areas. Traffic statistics in the south Okanagan range from an average of 2–14 cars per minute at various locations on Highway 97 during the summer (MOTH 1999).

Habitat threats

The primary threat to the Great Basin Spadefoot in British Columbia is likely habitat loss and fragmentation due to urban and agricultural development, for both breeding sites and foraging areas.

Livestock grazing can negatively impact Great Basin Spadefoot habitats due to soil and burrow compaction, trampling, loss of cover (riparian and grassland vegetation), and reduced water quality (Leupin et al. 1994; Cannings 1998; M. Sarell, pers. obs.). Leupin et al. (1994) found that nearly of all the surveyed ponds with spadefoot toads showed signs of livestock impact at the pond edge. Livestock may also create small depressions (hoof prints) that may trap developing eggs or larvae and which readily dry out, stranding the eggs or larvae.

Stocking lakes with sport fish may increase predation on spadefoot eggs and tadpoles. Loss of grasslands to recreational facilities such as golf courses reduces available foraging habitat. Off-road vehicles can cause disturbance to both grasslands and wetland edges. In grasslands, motor vehicles may cause soil compaction or erosion. At wetlands, vegetation and soil disturbance is largest when water levels are low and much of the foreshore is exposed, allowing access to a large area of mudflats. The resulting deep ruts may trap eggs or tadpoles as the pond dries.

Water management may benefit spadefoots by creating reservoirs, providing dependable breeding habitats in otherwise dry areas (Nussbaum 1983). Alternately, irrigation projects may decrease the availability of foraging areas through conversion to agricultural crops (Cannings 1998) and reduce the depth and duration of standing water. Further, irrigation may attract spadefoots to areas that are unsuitable for breeding, thus losing breeding opportunities for the season, due to the false appearance of available water.

Legal Protection and Habitat Conservation

The Great Basin Spadefoot is protected in that it cannot be killed, collected, or held in captivity without special permits, under the provincial *Wildlife Act*. The species is listed as Threatened under COSEWIC, and may be afforded some level of federal protection pending proposed legislation.

Two of the three largest populations are protected or partially protected by the Haynes Lease Ecological Reserve (100 ha), South Okanagan Wildlife Management Area, and Lac du Bois Provincial Park. The Nature Trust of BC owns lands that support smaller breeding populations of spadefoots. Other areas where they occur have recently been protected by the creation of White Lake Grasslands and South Okanagan Grasslands provincial parks.

Until the recent designation of the two grassland parks, only 6% (4600 ha) of suitable Great Basin Spadefoot habitat in the south Okanagan was designated as conservation lands, and 26% (~15 000 ha) was found on Crown land. Approximately 68% (about 40 000 ha) of suitable habitat is on Indian Reserves or private land (MELP 1998).

Identified Wildlife Provisions

Sustainable resource management and planning recommendations

Protect, and maximize connectivity between, known or suitable aquatic breeding sites and terrestrial non-breeding habitats (i.e., foraging and overwintering habitats). Identify potential and known ephemeral and cyclical aquatic breeding habitat.

Wildlife habitat area

Goal

Maintain suitable aquatic breeding habitats and integrity of adjacent terrestrial non-breeding habitat.

Feature

Establish WHAs at known breeding areas.

Size

Approximately 10 ha but will depend on site-specific factors such as size of water feature and extent of surrounding suitable habitat.

Design

The WHA should include a core area and may include a management zone. The core area should include the aquatic breeding site(s) and suitable uplands within ~250 m to protect most of the aestivation habitat. A management zone may be included to capture high quality habitat or to provide connectivity between populations.

General wildlife measures

Goals

1. Minimize disturbance during the breeding season.
2. Minimize road mortality.
3. Maintain water quality.
4. Maintain water levels.
5. Minimize soil disturbance and trampling of burrows.
6. Maintain important habitat features (i.e., small mammal burrows, riparian and emergent vegetation, and non-compacted soils).
7. Maintain or remediate riparian and aquatic habitats to a properly functioning condition.

Measures

Access

- As recommended by MWLAP, do not construct roads, deactivate temporary road structures, and close roads during critical times. Drift fences and culverts may be recommended by the statutory decision maker for locations where road mortality is extensive.
- Do not construct roads, although skidder trails may be acceptable on drier sites or in the winter.
- Do not place landings within core or management zone.

Harvesting and silviculture

- Do not harvest within core area.
- Minimize ground disturbances and do not scarify harvested areas.
- Stock only to natural densities, maintaining open forest characteristics with clearings, as per an NTD4 fire maintained ecosystem.

Pesticides

- Do not use pesticides.

Range

- Plan livestock use in the core area to meet objectives described above (GWM goals). Exclusion fencing may be required by the statutory decision maker to meet objectives.
- Do not place livestock attractants within WHA.

Additional Management Considerations

Maintain water levels and avoid draining wetland habitats.

Maintain ephemeral water features.

Prevent fish introductions in permanent water bodies.

Prevent incompatible recreation activities and prevent off-road vehicle access.

Encourage private land stewardship where important habitat extends beyond Crown land.

Information Needs

1. Distribution, both inside and outside of known range.
2. Limiting habitat (aquatic and terrestrial) and factors.
3. Movement and dispersal patterns.

Cross References

Badger, Burrowing Owl, Fringed Myotis, Grasshopper Sparrow, "Great Basin" Gopher Snake, Racer, "Sagebrush" Brewer's Sparrow, Sage Thrasher, Tiger Salamander, Western Rattlesnake

References Cited

B.C. Ministry of Environment, Lands and Parks (MELP). 1998. Habitat atlas for wildlife at risk: South Okanagan and Lower Similkameen. Penticton, B.C.

B.C. Ministry of Transportation and Highways (MOTH). 1999. Traffic volumes: Thompson Okanagan Region. 1995–1999. Victoria, B.C.

Cannings, R.J. 1998. COSEWIC status report on the Great Basin Spadefoot Toad (*Spea intermontana*) in Canada. Report prepared for the Committee on Endangered Wildl. in Canada, Ottawa, Ont.

Cannings, S.G., L.R. Ramsay, D.F. Fraser, and M.A. Fraker. 1999. Rare amphibians, reptiles and mammals of British Columbia. B.C. Min. Environ., Lands and Parks, Wildl. Br. and Resour. Inv. Br., Victoria, B.C.

Committee on the Status of Endangered Wildlife in Canada (COSEWIC). 2002. Canadian species at risk. Available from: http://www.speciesatrisk.gc.ca

Corkran, C.C. and C. Thoms. 1996. Amphibians of Oregon, Washington and British Columbia. Lone Pine Publishing, Vancouver, B.C.

Green, D.M. 1999. The amphibians of British Columbia: A taxonomic catalogue. B.C. Min. Environ., Lands and Parks, Wildl. Br. and Resour. Inv. Br., Victoria, B.C. Wildl. Bull. No. B-87.

Green, D.M. and R.W. Campbell. 1984. The amphibians of British Columbia. B.C. B.C. Prov. Mus., Victoria, B.C. Handb. No. 45.

Leupin, E., D.J. Low, and B. Persello. 1994. Census and life history observations of the Great Basin Spadefoot Toad (*Scaphiopus intermontanus*) breeding populations in the Thompson Nicola regions. Prepared for B.C. Environ., Kamloops, B.C.

Low, B. 1976. The evolution of amphibian life histories in the desert. *In* Evolution of desert biota. D.W. Goodall (editor). Univ. Texas Press, Austin, Tex., pp. 149–195.

NatureServe Explorer. 2002. An online encyclopedia of life [Web application]. Version 1.6. Arlington, Va. Available from: http://www.natureserve.org/explorer

Nussbaum, R.A., E.D. Brodie, and R.M. Storm. 1983. Amphibians and reptiles of the Pacific Northwest. Univ. Idaho Press, Moscow, Idaho.

Redpath, K. 1990. Identification of relatively undisturbed areas in the south Okanagan and Similkameen valleys, British Columbia. Can. Wildl. Serv., Pacific and Yukon Region, Tech. Rep. Ser. No. 108.

St. John, D. 1993. Census of the breeding distribution of the Great Basin Spadefoot Toad, *Scaphipus intermontanus*, in the south Okanagan Valley. Prepared for B.C. Environ., Wildl. Br., and Okanagan Region Wildl. Heritage Fund Soc., Penticton, B.C.

Seburn, D. and C. Seburn. 2000. Conservation priorities for the amphibians and reptiles of Canada. Prepared for World Wildl. Fund Canada and the Canadian Amphibian and Reptile Conserv. Network.

Weber, W. 1996. Spadefoot Toad locations, Merritt Forest District. Letter, map, and data on road surveys. B.C. Min. Environ., Lands and Parks, Merritt, B.C.

Wiens, J.J. and T.A. Titus. 1991. A phylogenetic analysis of *Spea* Anura Pelobatidae. Herpetologica 47:21–28.

NORTHERN LEOPARD FROG

Rana pipiens

Original prepared by I.A. (Penny) Ohanjanian and Kathy Paige

Species Information

Taxonomy

The Northern Leopard Frog belongs to the family Ranidae (true frogs) and the genus *Rana*. No subspecies are currently recognized (Green 1999).

Description

The Northern Leopard Frog is a medium-sized (50–100 mm snout-vent-length [svl]), semi-terrestrial frog. Distinguishing characteristics include two conspicuous cream-coloured dorsolateral folds that extend the length of the back and large, distinct, solid dark brown or olive spots with smooth pale borders on head, back, sides, and legs (Green and Campbell 1984); legs are long, and webbing does not extend to tips of toes. Typically the dorsal surface is green or brown and the ventral surface is white. Tadpoles are ~25 mm svl, dark brown and speckled with gold spots. The eyes are bronze-coloured. The height of the dorsal fin is equal to or less than the thickness of tail trunk at its base. See detailed description in Corkran and Thoms (1996).

Distribution

Global

The Northern Leopard Frog is part of a group of anurans (the Leopard Frog complex) that is widely distributed throughout North America. In Canada, populations exist from southeastern British Columbia east to the Maritimes, while in the United States, the species ranges south to California and New Mexico and east to South Carolina (Stebbins and Cohen 1995). In parts of the mid-West and western portions of its range, however, populations of Northern Leopard Frog have disappeared or declined significantly (Hine et al. 1981; Roberts 1992; Seburn 1992; Corn and Fogleman 1994; McAllister et al. 1999).

British Columbia

In British Columbia, the Northern Leopard Frog historically occurred in the Kootenay and Columbia River valleys and in the Rocky Mountains east of Fernie near Corbin (Seburn and Seburn 1998). The species was also reported from Osoyoos Lake in the Okanagan Valley (Carl 1949). The most northerly location was Bush Arm, 70 km north of Golden, with other sightings in marshes and ponds along the Columbia and Kootenay River systems from Golden south to Newgate near the U.S. border (Seburn and Seburn 1998). None have since been recorded at these locations although surveys were carried out in the late 1990s (Ohanjanian and Teske 1996; Gillies and Franken 1999). Today the Northern Leopard Frog is known from only one site in the Creston Valley Wildlife Management Area (Ohanjanian 1997; Waye and Cooper 1999). An population which is believed to have been introduced in the 1930s (Green 1978) was found at Parksville (Hamilton Marsh) on Vancouver Island in 1976. The current status of this population is not known (L. Friis, pers. comm.).

Forest region and districts

Coast: South Island (introduced)

Southern Interior: Columbia, Kootenay Lake (extant), Okanagan Shuswap (Penticton – historic), Rocky Mountain

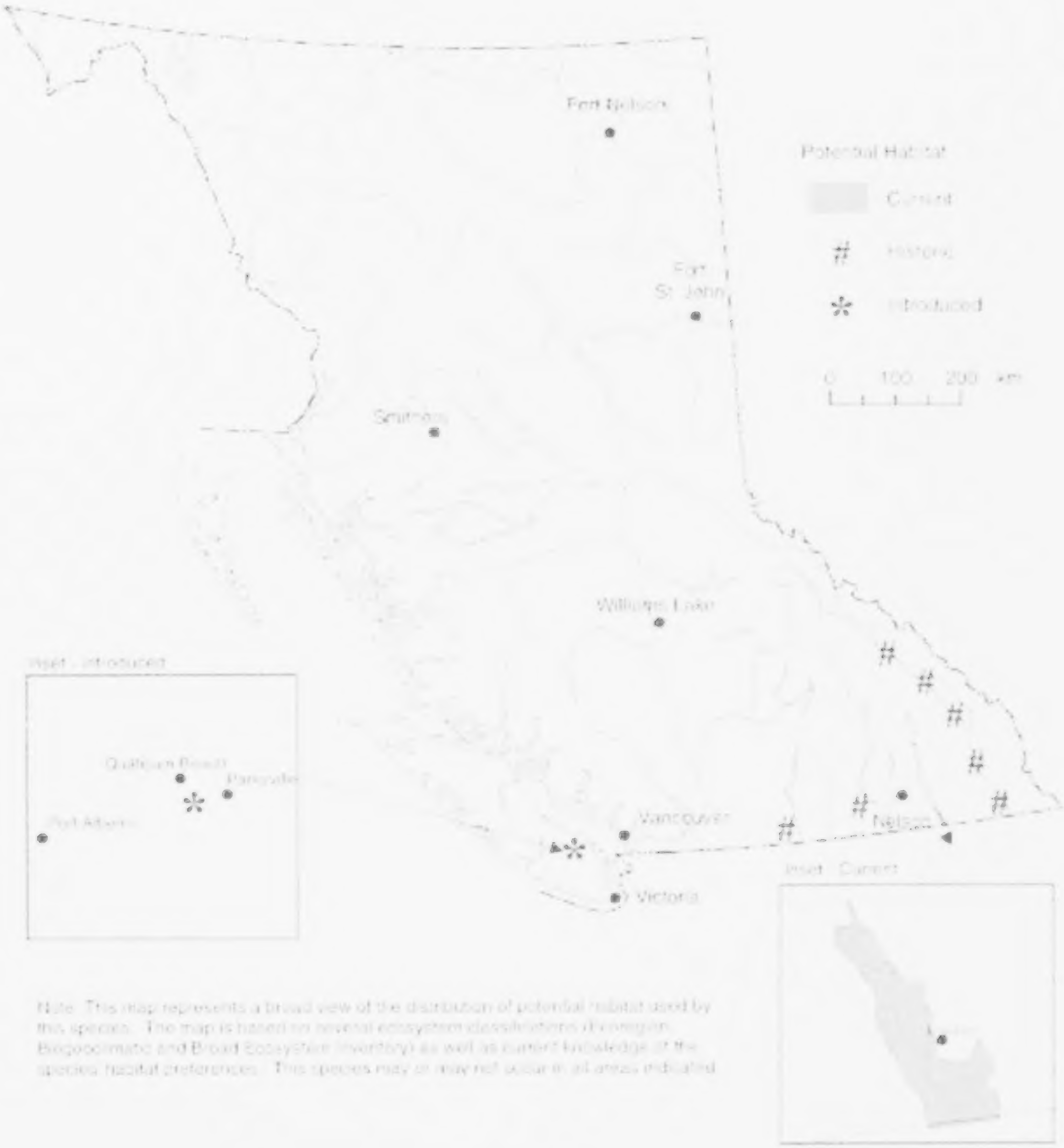
Ecoprovinces and ecosections

CED: NAL (introduced)

SIM: EKT (historic), FLV (historic), SCM (current), UCV (historic)

SOI: NOB (historic), OKR (historic), SOB (historic)

Northern Leopard Frog
(Rana pipens)


Fort Nelson
Fort St. John
Smithers
Williams Lake
Vancouver
Victoria
Nelson
Potential Habitat
Current
# Historic
* Introduced
0 100 200 km
Inset - Introduced
Qualicum Beach
Parksville
Port Alberni
Inset - Current

Note: This map represents a broad view of the distribution of potential habitat used by this species. The map is based on several ecosystem classifications (Ecoregion, Biogeoclimatic and Broad Ecosystem Inventory) as well as current knowledge of the species' habitat preferences. This species may or may not occur in all areas indicated.

Biogeoclimatic units

BG: xh1 (historic)
CDF: mm (introduced)
ICH: xw (current)
ICH: dw, mk1 (historic), mw2
IDF: dm2 (historic)
MS: dk (historic)
PP: xh1 (historic)

Broad ecosystem units

CF, CR, LS, OW, RR, WL, WR

Elevation

82–1400 m

Life History

Diet and foraging behaviour

The Northern Leopard Frog is an opportunistic forager. Its diet consists of a variety of prey including insects, arachnids, worms, crustaceans, and other small vertebrate prey (McAllister et al. 1999). Adults and juveniles forage primarily on land. Tadpoles graze on phytoplankton, algae, periphyton, and detritus.

Reproduction

Sexual maturity is most commonly reached in 2 years, but this may vary from 1 to 3 years. Generally, courtship begins in mid-April after adult frogs have left overwintering habitat and arrived at breeding sites. Males congregate in the shallow waters at breeding sites and begin calling in mid-April. This may last until June (Waye and Cooper 1999). The time of egg deposition varies with latitude and elevation (Fichter and Linder 1964), and in British Columbia this occurs most often in April and May (Orchard 1984; Waye and Cooper 1999). Females deposit a single egg mass, which may contain between 600 and 7000 eggs (Corn and Livo 1989). Females tend to deposit egg masses close to each other, where two to several dozen egg masses may occur over a small area (Nussbaum et al. 1983; Wright and Wright 1995). Egg masses are attached to submerged vegetation in shallow water but may occasionally be deposited on the surface (Hine et al. 1981; Corkran and Thoms (1996). A variety of plant species are used, including sedges (*Carex* spp.), bullrushes (*Scirpus* spp.) (Hine et al. 1981; Corn and Livo 1989), cattails, twigs, or even grass (Wright and Wright 1995). In British Columbia, spikerush (*Eleocharis palustris*) is used (Waye 2000). Eggs hatch within 9 days and metamorphosis can occur in as little as 2 months (68.2–86.0 days; Corn 1981). Metamorphosis occurs in July and August (Orchard 1984; Waye and Cooper 1999). A number of environmental factors, including water temperature, can influence development rates at all stages.

Site fidelity

Northern Leopard Frogs appear to exhibit strong site fidelity to breeding and overwintering sites (Waye and Cooper 1999; T. Antifeau, pers. comm.), while greater flexibility is probable with respect to foraging areas (M.A. Beaucher, pers. comm.).

Home range

Adults maintain small home ranges ranging from 15 to 600 m^2 (Dole 1965). Radio-telemetry work suggests that frogs prefer to spend long periods at the edge of water bodies (Waye and Cooper 1999).

Movements and dispersal

Movements can occur at night or during the day (Merrell 1977; Seburn et al. 1997). Generally, adult Northern Leopard Frogs do not move very far (i.e., 5–10 m but occasionally 100 m) (Doyle 1965). Waye (2000) found that radio-tagged leopard frogs would not move for several days, then move 5–50 m away but return to their original location. On a seasonal basis, leopard frogs move greater distances. Northern Leopard Frogs move from overwintering sites in April to breeding ponds. The distance between breeding and overwintering locations can be a few metres or up to several kilometres (Merrell 1977). If breeding sites are ephemeral, the frogs will move, after breeding, to more permanent wetlands for the remainder of the summer (Nussbaum et al. 1983; Cannings et al. 1999). Metamorphs typically remain within 20 m of shoreline although some disperse before metamorphosis is complete. Metamorphs dispersing from natal sites generally disperse within a couple of kilometres but have been recorded to disperse up to 8 km from natal sites (Seburn et al. 1997) and can move up to 800 m a night (Dole 1971). Migration back to overwintering sites may begin as early as August (M.A. Beaucher, pers. comm.) with the bulk of the movement occurring in September and October.

Habitat

Structural stage

2a–d: herb
3a: low shrub

Important habitats and habitat features

Aquatic

Aquatic habitats are needed for breeding and overwintering. The Northern Leopard Frog breeds in a variety of temporary and permanent aquatic habitats. Shallow water depths, abundant emergent vegetation, and absence of predatory fish species are important characteristics of most successful breeding sites (Merrell 1977; Leonard et al. 1993). Temporary aquatic habitats that hold water until late July or August or permanent ponds will reduce the risk that eggs or larvae may die as water levels drop. On the other hand, wetlands that dry up every few years prevent the establishment of fish populations. In Minnesota, preferred aquatic habitats were temporary ponds with a water depth of 1.5–2 m where fish were absent (Merrell 1968). In British Columbia, however, leopard frogs use wetland areas with shallow (20–30 cm), open water and beds of spikerush for breeding (Waye and Cooper 1999).

Deeper water that does not freeze to the bottom is required for overwintering sites. Northern Leopard Frogs typically spend the winter on the bottom of wetlands or streams often in organic debris or leaf litter, or under logs. Overwintering habitats must also maintain sufficient oxygen to prevent the water from becoming anoxic (Merrell 1977; Cunjak 1986).

Terrestrial

Terrestrial habitats are important for foraging and dispersal. This species forages in moist terrestrial environments, typically riparian habitats, but may move farther during wet periods. Although it may forage in a variety of terrestrial habitats, habitats with short (15–30 cm tall) vegetation appear to be preferred and tall (>1 m) grass areas are avoided, as are wooded areas, open areas, and heavily grazed or mowed areas (Merrell 1977).

Riparian habitat may be important, particularly in drier environments, for dispersal (Seburn et al. 1997).

Conservation and Management

Status

The Northern Leopard Frog is on the provincial *Red List* in British Columbia. In Canada, the southern mountain population is designated as *Endangered* (COSEWIC 2002). (See Summary of ABI status in BC and adjacent jurisdictions at bottom of page.)

Trends

Population trends

The Northern Leopard Frog has undergone a significant and widespread population decline in the last 20 years in western Canada and the United States (Bishop and Pettit 1992; Seburn and Seburn 1998). In British Columbia, only one extant site remains and the current estimated population is 1000 adults (Waye and Cooper 1999).There are at least 12 historic sites (Waye 2000). These records indicate a much wider distribution and abundance in the 1940s through 1970s than has been observed since that time. In the 1970s the species was described as

Summary of ABI status in BC and adjacent jurisdictions (NatureServe Explorer 2002)

AB	BC	CA	ID	MT	OR	WA	Canada	Global
S2S3	S1	S2	S3	S3S4	S2?	S1	N5	G5

being numerous in the Creston area but by the early 1980s it was considered uncommon (Ohanjanian 1996). Surveys conducted from 1988 to 1990 (Orchard 1992) and 1995 (Ohanjanian and Teske 1996) were largely unsuccessful at locating leopard frogs. Northern Leopard Frogs have only been consistently reported, although in relatively low numbers (4 in 1991, 7 in 1996, 37 in 1997, 116 in 1998, 150 in 1999), from one area (i.e., Creston Wildlife Management Area) (Orchard 1992; Ohanjanian 1996; Waye 2000).

Significant declines have also been experienced in jurisdictions adjacent to British Columbia including Alberta, Idaho, Montana, and Washington. In Washington, the Northern Leopard Frog was historically known from eight counties but is currently only known from one (McAllister et al. 1999). Populations in southern and central Alberta have also declined dramatically (Roberts 1992; Wagner 1997), and in southern Idaho (Koch et al. 1996) and Montana (Reichel et al. 1996).

Habitat trends

Within the historic range of the Northern Leopard Frog, land use changes have resulted in the loss and alteration of some aquatic and riparian habitats. This is particularly true of Osoyoos Lake, which has seen increased urbanization and agricultural development since the late 1940s. The flooding of the Kinbasket Reservoir has altered habitat in the Bush Arm area. Much of the Columbia Marshes, however, have remained relatively unchanged. In the Creston Valley Wildlife Management Area (CVWMA), approximately 4500 ha of 6970 ha have been dyked (Frazier 1996). Dyking at the CVWMA created permanent ponds which tend to favour predatory fish populations and probably created barriers to seasonal frog movements. These negative effects may have been partially offset by the creation in some areas of relatively stable water levels and development of submergent and emergent plant communities in areas that had previously been exposed mud flats.

Threats

Population threats

There is only one extant site remaining in British Columbia (Cannings et al. 1999) which makes this species vulnerable to extirpation.

Non-native predatory fish, such as bass (*Micropterus* spp.), black bullhead (*Ameiurus melas*), and sunfish (*Lepomis* spp.), may displace and prey on native frog eggs, tadpoles, and metamorphs (Orchard 1992; Hayes and Jennings 1986). The introduction of predatory fish and bullfrogs into habitats occupied by Northern Leopard Frogs has contributed to the decline of leopard frogs in Washington (McAllister et al. 1999) and California (Hayes and Jennings 1986), and have been found to negatively impact Northern Leopard Frogs in Ontario (Hecnar and M'Closkey 1997). In addition, introduced plant species, such as purple loosestrife, can also alter wetland habitats making them less suitable or increasing the rate of eutrophication.

The role of infectious agents in amphibian declines and their interaction with stressed immune systems is currently under intense study. Diseases, such as Red-leg disease (a common bacterial infection in amphibians and fish), is believed to be implicated in a die-off of Northern Leopard Frogs in the 1970s (Bishop and Pettit 1992). Chytridiomycosis and other fungi have been shown to cause mortality associated with amphibian declines (Blaustein et al. 1994b; Berger et al. 1998) around the world. Ranaviruses too could be having an impact on herpetofauna globally, and may be contributing to the observed decline in amphibian numbers in some areas (Cullen and Owens 2000).

Numerous chemical applications are used in urban and agricultural environments. Fertilizer (ammonium nitrate) has been found to be toxic to Northern Leopard Frogs (Hecnar 1995), and larval amphibians are vulnerable to low levels of pesticides (Berrill et al. 1997). Possible effects on amphibian populations may be lowered reproductive capacity, deformities, and reduced ability to avoid predators.

In dry years, temporary aquatic habitats may be less available or dry up earlier resulting in reduced reproductive success and increased mortality (Hine et al. 1981). Drought, which can result in breeding habitats drying up, has been suggested as contributing to the disappearance of Northern Leopard Frogs in the Rocky Mountains (Corn and Fogleman 1984), but this does not appear to have been the case in British Columbia. The long-term local effects of global climate change in the Columbia basin are not known.

Increased UV-B radiation has been shown to affect developing amphibian embryos (Blaustein et al. 1994a); the degree to which this may be naturally offset by environmental factors (such as dissolved organic matter) is currently under study.

Historically this species was commercially collected in large numbers for scientific and educational studies.

Habitat threats

The loss, fragmentation, and alteration of wetland habitat is the primary threat to habitats of the Northern Leopard Frog.

Livestock grazing may impact leopard frog populations through the loss or alteration of riparian vegetation and habitats. In addition, cattle can trample egg masses in shallow waters. Livestock defecation within aquatic or riparian habitats may also alter water conditions. Northern Leopard Frogs rarely occur in heavily grazed areas (Merrell 1977).

Conversion of wetlands into croplands, such as hay or grain, has a negative impact. Not only is wetland habitat lost, but terrestrial foraging may be hampered by thick stands of alfalfa or cereal crops.

Urban development usually results in the draining of wetlands, the dumping of road wastes into wetlands, and destruction of riparian zones. Even if the wetlands *per se* are maintained, roads that are constructed between breeding, foraging, and/or overwintering habitats results in increased road mortality during seasonal migrations (Merrell 1977).

Alterations to hydrological regimes brought about by channelling, dyking, irrigating, and draining can have severe impacts on Northern Leopard Frogs. Overuse of aquifers by domestic wells and irrigation can lower the water table and reduce the occurrence of temporary wetlands (Corn and Fogleman 1984). Streamside aquatic vegetation may be affected by channelling, which in turn may affect both the prey base and the quantity of cover available. Hydrological changes can result in lower available dissolved oxygen in wintering sites, a factor that is crucial for overwintering survival (Cunjak 1986). Canals and ditches may connect previously isolated wetlands to those with predatory fish populations. Conversely, dyking may strand tadpoles in areas where water levels dry out (Wagner 1997) and steep slopes may impede movements of metamorphs and adults.

Legal Protection and Habitat Conservation

The Northern Leopard Frog is protected, in that it cannot be killed, collected, or held in captivity without special permits, under the provincial *Wildlife Act*.

Northern Leopard Frogs require the protection of aquatic breeding and overwintering habitat and terrestrial foraging habitat.

The only extant site remaining in British Columbia is within the Creston Valley Wildlife Management Area (6970 ha). The Creston Valley is listed by the International Convention on Wetland Protection as a wetland of international importance (Frazier 1996). Suitable habitat is also included within the Columbia National Wildlife Area (Cannings et al. 1999). Approximately 82 720 ha of wetland habitat is included within National Wildlife Areas, Wildlife Management Areas, and other unofficial areas managed for wildlife in the Columbia Valley. However some industrial and recreational activities are permitted within these areas.

Under the results based code (RBC), riparian buffers are required on lakes, wetlands, and streams.

However, small non-classified wetlands and small fishless streams do not receive any protection. The most critical components for terrestrial habitat are sufficient cover and, on a larger scale, connectivity between wetlands and overwintering sites to maintain metapopulation dynamics in the landscape. Connectivity of habitats is not explicitly addressed under the RBC but may occur through landscape level planning.

The Northern Leopard Frog Recovery Team is currently developing recommendations for reintroducing populations into suitable habitat. The intent is to establish five viable populations of Northern Leopard Frog within 10 years in the Kootenay, Columbia, and Creston valleys. In 2001and 2002, 480 and 2300 metamorphs, respectively, were reintroduced into another area of the CVWMA (M.A. Beaucher, pers. comm.).

Identified Wildlife Provisions

Wildlife habitat area

Goal

Maintain suitable habitat for reintroduction of Northern Leopard Frogs.

Feature

Establish WHAs at suitable sites as determined by the provincial recovery team or action group. The WHA should encompass all necessary attributes including aquatic breeding habitat, terrestrial foraging habitat, and overwintering habitat.

Size

Based on research on the only extant population in British Columbia, a WHA that is 1 × 2 km is recommended.

Design

The WHA should include a wetland breeding site, adjacent terrestrial foraging habitat, and an overwintering site. This last feature should be within 1.7 km of the breeding/foraging habitat, and <800 m where possible. The WHA should generally include a 50 m management zone surrounding the habitat features of the WHA (wetland, riparian habitats, overwintering site). When selecting and designing the boundaries of the WHA, maintain or restore connectivity between the aquatic-breeding habitat, terrestrial foraging habitat, and overwintering sites (if different than breeding site). The establishment of a metapopulation structure over more than one locale may be assisted if streams are present to facilitate movement and colonization (Seburn et al. 1997).

General wildlife measure

Goals

1. Maintain structural integrity and abundance of submergent and emergent vegetation (i.e., spikerush) to provide egg-laying sites and rearing habitat for developing tadpoles.
2. Maintain riparian vegetation to provide cover, but manage sites to reduce abundance of overly thick reed canary grass stands that would impede movement. Good cover to lower predation during seasonal migration is beneficial.
3. Maintain water quality and water levels.
4. Maintain WHA in a properly functioning condition.
5. Prevent or reduce road mortality.

Measures

Access

- Do not construct roads, deactivate temporary road structures, and close roads during critical times as recommended by MWLAP. Barrier fences may be recommended by the statutory decision maker for locations where road mortality is extensive.

Pesticides

- Do not use pesticides.

Range

- Plan livestock use in the core area to meet objectives described above (GWM goals). Exclusion fencing may be required by the statutory decision maker to meet objectives.
- Do not place livestock attractants within WHA.

Additional Management Considerations

Minimize road mortality by avoiding road developments that intersect known dispersal routes or incorporating barrier fences and "toad tunnels" to enable the safe passage of frogs.

Prevent introduction of fish species into suitable habitats for Northern Leopard Frogs.

Prevent or minimize wetland drainage, dyking, or flooding.

Information Needs

1. Suitability of proposed release sites must be assessed and compared with known areas of occupation.
2. Knowledge of the genetic structure of populations in British Columbia, Washington, Idaho, and Montana would be useful in deciding source populations for release sites.
3. Further study of the cause(s) of the Northern Leopard Frog decline in the west may provide information on the suitability of potential release sites.

References Cited

Berger L., R. Speare, P. Daszak, D.E. Green, A.A. Cunningham, C.L. Goggin, R. Slocombe, M.A. Ragan, A.H. Hyatt, K.R. McDonald, H.B. Hines, K.R. Lips, G. Marantelli, and H. Parkes. 1998. Chytridiomycosis causes amphibian mortality associated with population declines in the rain forests of Australia and Central America. Proc. Natl. Acad. Sci. (U.S.A.) 95:9031–9036.

Berrill, M., S. Bertram, and B. Pauli. 1997. Effects of pesticides on amphibian embryos and larvae. *In* Amphibians in decline: Canadian studies of a global problem. D.M. Green (editor). Herpetol. Conserv. 1:233–245.

Bishop, C.A. and K.E. Pettit. 1992. Declines in Canadian amphibian populations: designing a national strategy. Can. Wildl. Serv., Ottawa, Ont. Occas. Pap. No. 76.

Blaustein, A.R., P.D. Hoffman, D.G. Hokit, J.M. Kiesecker, S.C. Walls, and J.B. Hays. 1994a. UV repair and resistance to solar UV-B in amphibian eggs: A link to population declines? Proc. Natl. Acad. Sci. 9:1791–1795.

Blaustein, A.R., D.G. Hokit, R.K. O'Hara, and R.A. Holt. 1994b. Pathogenic fungus contributes to amphibian losses in the Pacific Northwest. Biol. Conserv. 67:251–254.

Cannings, S.G., L.R. Ramsay, D.F. Fraser, and M.A. Fraker. 1999. Rare amphibians, reptiles and mammals of British Columbia. B.C. Min. Environ., Lands and Parks, Wildl. Br. and Resour. Inv. Br., Victoria, B.C. 198 p.

Carl, G.C. 1949. Extensions of known ranges of some amphibian species in British Columbia. Herpetologica 5:139–140.

Committee on the Status of Endangered Wildlife in Canada (COSEWIC). 2002. Canadian species at risk. Available from: http://www.speciesatrisk.gc.ca

Corkran, C.C. and C. Thoms. 1996. Amphibians of Oregon, Washington and British Columbia. Lone Pine Publishing, Vancouver, B.C.

Corn, P.S. and L.J. Livo. 1989. Leopard frogs and wood frog reproduction in Colorado and Wyoming. Northwest. Nat. 70:1–9.

Corn, P.S. and J.C. Fogleman. 1984. Extinction of montane populations of the northern leopard frog (*Rana pipiens*) in Colorado. J. Herpet. 18:147-152.

Cullen, B.R. and L. Owens. 2000. Ranaviruses and amphibians. *In* Abstracts of Getting the Jump! on Amphibian Diseases Conf., Cairns, Australia, Aug. 26–30, 2000.

Cunjak, R.A. 1986. Winter habitat of northern leopard frogs, *Rana pipiens*, in a southern Ontario stream. Can. J. Zool. 64:255–257.

Dole, J.W. 1965. Summer movements of adult leopard frogs, *Rana pipiens* Schreber, in northern Michigan. Ecology 46(3):236–255.

Fichter, E. and A.D. Linder. 1964. The amphibians of Idaho. Idaho State Univ. Mus. Spec. Publ. 34 p.

Frazier, S. 1996. Directory of wetlands of international importance: an update. Ramsar. Available from: http://www.ramsar.org/lib_dir96_6.htm

Gillies, C. and R. Franken. 1999. East Kootenay Northern Leopard Frog Project. Report for Living Landscapes Program, B.C. Min. Environ., Lands and Parks, Victoria, B.C. Unpubl.

Green, D.M. 1978. Northern leopard frogs and bullfrogs on Vancouver Island. Can. Field-Nat. 92(1):78–79.

______. 1999. The amphibians of British Columbia: A taxonomic catalogue. B.C. Min. Environ., Lands and Parks, Wildl. Br. and Resour. Inv. Br., Victoria, B.C. Wildl. Bull. No. B-87.

Green, D.M. and R.W. Campbell. 1984. The amphibians of British Columbia. B.C. Prov. Mus., Min. Prov. Secretary and Government Serv., Victoria, B.C. Handb. No. 45.

Hayes, M.P. and M.R. Jennings. 1986. Decline of ranid frogs in western North America: are bullfrogs (*Rana catesbeiana*) responsible? J. Herpet. 20(4):490–509.

Hecnar, S.J. 1995. Acute and chronic toxicity of ammonium nitrate fertilizer to amphibians from southern Ontario. Environ. Toxicol. Chem. 14 (12):2131–2137.

Hecnar, S.J. and R.T. M'Closkey. 1997. The effects of predatory fish on amphibian species richness and distribution. Biol. Conserv. 79:123–131.

Hine, R.L., B.C. Les, and B.F. Hellmich. 1981. Leopard frog populations and mortality in Wisconsin. Dep. Nat. Resour., Madison, Wis. Tech. Bull. No. 122.

Koch, E.G., G. Williams, C.R. Peterson, and P.S. Corn. 1996. A summary of the conference on declining and sensitive amphibians in the Rocky Mountains and Pacific Northwest. Idaho Herpetological Soc. and U.S. Fish and Wildl. Serv., Snake River Basin Office Rep., Boise, Idaho.

Leonard, W.P., H.A. Brown, L.L.C. Jones, K.R. McAllister and R.M. Storm. 1993. Amphibians of Washington and Oregon. Seattle Audubon Soc., Seattle, Wash.

McAllister, K.R., W.P. Leonard, D.W. Hayes, and R.C. Friesz. 1999. Washington State status report for the northern leopard frog. Wash. Dep. Fish and Wildl., Olympia, Wash. 36 p.

Merrell, D.J. 1977. Life history of the leopard frog, *Rana pipiens*, in Minnesota. Bell Mus. Nat. History, Univ. Minn. Occas. Pap. No. 15.

NatureServe Explorer. 2002. An online encyclopedia of life [Web application]. Version 1.6. Arlington, Va. Available from: http://www.natureserve.org/explorer

Nussbaum, R.A., E.D. Brodie, Jr., and R.M. Storm. 1983. Amphibians and reptiles of the Pacific Northwest. Univ. Press Idaho, Idaho Res. Found., Moscow, Idaho.

Ohanjanian, I.A. 1997. The Northern Leopard Frog, *Rana pipiens*, in the Creston Valley Wildlife Management Area. Report prepared for the Columbia Basin Fish and Wildlife Compensation Program, Nelson, B.C.

Ohanjanian, I.A. and I.E. Teske. 1996. Herpetological surveys of 87 wetlands in the Columbia Basin fish and wildlife compensation area. Report for Columbia Basin Fish and Wildlife Compensation Program, Nelson, B.C. Unpubl.

Orchard, S.A. 1984. Amphibians and reptiles of British Columbia: an ecological review. B.C. Min. For., Res. Br., Victoria, B.C. WHR-15.

______. 1992. Amphibian population declines in British Columbia. *In* Declines in Canadian amphibian populations: designing a national monitoring strategy. C.A. Bishop and K.E. Pettit (editors). Can. Wildl. Serv., Environ. Canada, Ottawa, Ont. Occas. Pap. No. 76, pp. 10–13.

Reichel, J.D., J.K. Werner, D.P. Hendricks, and T. Plummer. 1996. Status of Northern Leopard Frogs and Western Toads in Montana. *In* A summary of the conference on declining and sensitive amphibians in the Rocky Mountains and Pacific Northwest. E.D. Koch, G. Wood, C.R. Peterson, and P.S. Corn (editors). Nov. 7–8, 1996, Boise, Idaho, pp. 49–50.

Roberts, W. 1992. Declines in amphibian populations in Alberta. *In* Declines in Canadian amphibian populations: designing a national monitoring strategy. C.A. Bishop and K.E. Pettit (editors). Can. Wildl. Serv., Environ. Can., Ottawa, Ont. Occas. Pap. No. 76, pp. 14–16.

Seburn, C.N.L. 1992. The status of amphibian populations in Saskatchewan. *In* Declines in Canadian amphibian populations: designing a national monitoring strategy. C.A. Bishop and K.E. Pettit (editors). Can. Wildl. Serv., Environ. Can., Ottawa, Ont. Occas. Pap. No. 76.

Seburn, C.N.L. and D.C. Seburn. 1998. Status report on western populations of the northern leopard frog, *Rana pipiens*, in Canada (western populations). Report prepared for Committee on the Status of Endangered Wildl. in Canada, Ottawa, Ont.

Seburn, C.N.L., D.C. Seburn, and C.A. Paszkowski. 1997. Northern leopard frog (*Rana pipiens*) dispersal in relation to habitat. *In* Amphibians in decline: Canadian studies of a global problem. D.M. Green (editor). Society for the Study of Amphibians and Reptiles, St. Louis, Mo., pp. 64–72.

Stebbins, R.C. and N.W. Cohen. 1995. A natural history of amphibians. Princeton Univ. Press, Princeton, N.J.

Wagner, G. 1997. Status of the Northern Leopard Frog (*Rana pipiens*) in Alberta. Alberta Environ. Prot., Wildl. Manage. Div., Edmonton, Alta. Wildl. Status Rep. No. 9.

Waye, H.L. 2000. Status of the northern leopard frog in the Creston Valley Wildlife Management Area, British Columbia. *In* Proc. Conf. on the Biology and Management of Species and Habitats at Risk, Kamloops, B.C., Feb. 15–19, 1999. L.M. Darling (editor). B.C. Min. Environ., Lands and Parks, Victoria, B.C., and Univ. Coll. Cariboo, Kamloops, B.C., pp. 413–414.

Waye, H.L. and J.M. Cooper. 1999. Status of the northern leopard frog in the Creston Valley Wildlife Management Area, British Columbia. Report for the Columbia Basin Fish and Wildlife Compensation Program. 52 p.

Wright, A.H. and A.A. Wright. 1995. Handbook of frogs and toads of the United States and Canada. Comstock Publishing Assoc., Ithaca, N.Y. and London, U.K., pp. 481–483.

Personal Communications

Antifeau, T. 2002. Min. Water, Land and Air Protection, Nelson, B.C.

Beaucher, M.A. 2002. Consultant, Creston, B.C.

RED-LEGGED FROG

Rana aurora aurora

Original prepared by Katherine A. Maxcy

Species Information

Taxonomy

The Red-legged Frog belongs to the family Ranidae (true frogs). Two subspecies are recognized: "Northern" Red-legged Frog (*Rana aurora aurora*) and "California" Red-legged Frog (*Rana aurora draytoni*). The "Northern" Red-legged Frog is the only subspecies that occurs in British Columbia.

Description

The Red-legged Frog is a medium-size anuran, ranging from 30 to 100 mm in snout-vent length (SVL). Adult females reach a larger body size (up to ~ 100 mm SVL) than do males (up to ~ 70 mm SVL). Juvenile frogs range from 18 to 40 mm SVL.

Adults have gold-coloured eyes that are oriented outward rather than upward as in Spotted Frog *(Rana pretiosa)*, with which it can be confused (Corkran and Thoms 1996). The colour of the ventral surface ranges from light golden to dark brown, possibly with a reddish tinge. Irregularly shaped black spots may also be present. Red-legged frogs have conspicuous dorso-lateral folds extending down either sides of the back. The undersides of the hind legs and lower belly are translucent red. In contrast to adults, juveniles may have little red on the thighs and belly and chest patterning is absent. In addition, the snout is short and rounded with a light, short lip line that may be quite indistinct.

Hatchlings average 12.4 mm total length and tadpoles reach lengths of 28.7 mm at metamorphosis (Brown 1975). Tadpoles have a stubby appearance and the tail is usually no longer than 1.5 times the body length. The overall body shape is oval with the dorsal fin taller than the thickness of the tail trunk. The ventral surface of the tadpole is tan with gold or brassy blotches. The dorsal fin may have a fine golden tone with light and gold-coloured dots, or it may be colourless (Corkran and Thoms 1996).

Distribution

Global

The Red-legged Frog occurs in the coastal lowlands of southwestern British Columbia, Washington, Oregon, and northern California.

British Columbia

The Red-legged Frog is found in the southwestern part of the province, including Vancouver Island and the Gulf Islands. On the mainland, the species occurs west of the Coast Mountains in the Fraser Valley and adjacent to the Strait of Georgia. Its northern limit in British Columbia has not been verified but may occur at least as far north as Kingcome Inlet (Waye 1999).

Forest region and districts

Coast: Campbell River, Chilliwack, North Island, South Island, Squamish, Sunshine Coast

Ecoprovinces and ecosections

COM: NIM, NWC, NWL, SPR, WIM
(possibly EPR, HEL, OUF)
GED: FRL, GEL, LIM, NAL, SGI

Biogeoclimatic units

CDF: mm
CWH: dm, ds, mm, vh, vm, wh, xm

Broad ecosystem units

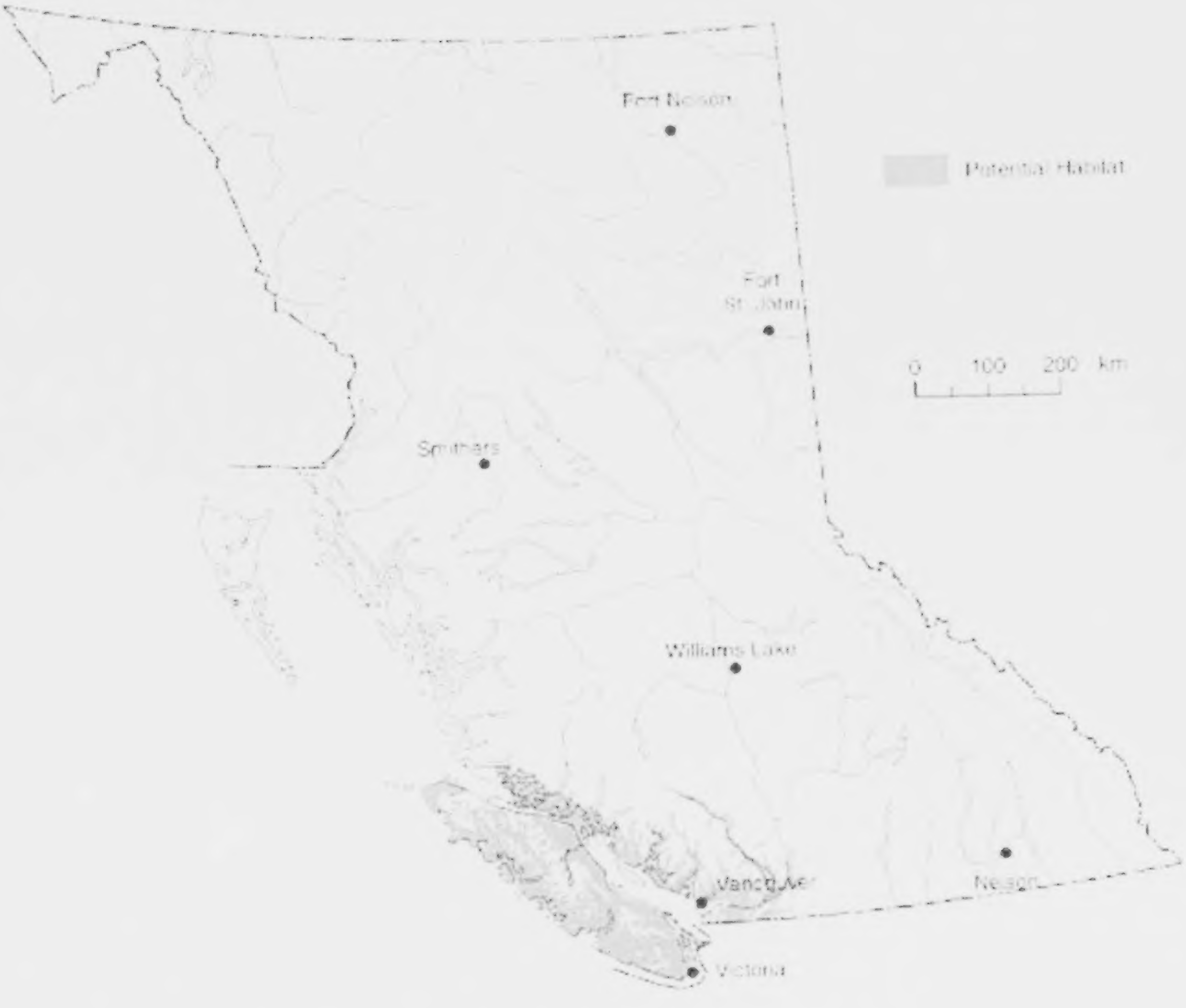
BG, CD, CG, CH, CP, CR, CW, DA, FE, FR, LS, ME, MR, OW, SP, SR, WL

Elevation

Generally at low elevations, mostly below 850 m.

Red-legged Frog

(Rana aurora)


Fort Nelson
Potential Habitat
Fort St. John
0 100 200 km
Smithers
Williams Lake
Vancouver
Nelson
Victoria

Note: This map represents a broad view of the distribution of potential habitat used by this species. The map is based on several ecosystem classifications (Ecoregion, Biogeoclimatic and Broad Ecosystem Inventory) as well as current knowledge of the species' habitat preferences. This species may or may not occur in all areas indicated.

Life History

Diet and foraging behaviour

Tadpoles are herbivorous and forage on filamentous algae in the water column, scraping algae off substrates, and possibly consuming decaying vegetation at the bottom of pools (Nussbaum et al. 1983).

Adult and juveniles are likely opportunistic foragers limited mainly by their gape in what they can eat (Licht 1986). The frogs feed mostly on land with dominant prey items including slugs, spiders, and many insects. The foraging behaviour of adult and juveniles is not easily observed. Newly metamorphosed individuals tend to remain near the water margins after emergence, stalking small prey in and out of the water (Licht 1986). During rainy periods, they may move several metres inland from the water's edge but return if substrates become dry. Metamorphosed frogs occasionally feed in aquatic habitats but are less efficient at capturing aquatic prey items than are the more aquatic Oregon Spotted Frog (Licht 1986).

Reproduction

Breeding occurs in a wide variety of wetlands including both temporary and permanent ponds, lakes, and slow-moving streams with emergent vegetation (Storm 1960; Brown 1975; Richter and Azous 1995; Beasley et al. 2000). Breeding activity is weather dependent. Frogs become active during rainy periods when daytime temperatures are >4–5°C (Storm 1960; Licht 1969, Calef 1973a) and begin moving to breeding sites. In southwestern British Columbia, breeding usually begins in late February to early March and lasts 2–4 weeks (Licht 1969; Brown 1975).

Males arrive at the breeding sites up to 1 week before females (Licht 1969). Males typically call underwater (Calef 1973b). Females are thought to reproduce every year (Licht 1969), laying an average of about 600 eggs per clutch with larger females producing more eggs. For egg-laying to occur, water temperatures must be at least 4°C (Licht 1969, 1971; Calef 1973b). The egg masses are attached to stalks of emergent vegetation (e.g., rushes and sedges) in quiet water of little or no flow (Storm 1960; Licht 1969; Briggs 1987; Richter and Azous 1995). Water depths range from 30 to 500 cm deep and are at least 60 cm from the shoreline (Briggs 1987). The placement of eggs below the surface of the water prevents the eggs from being stranded above the high watermark as water recedes. The egg masses are also protected from thermal extremes, as water temperature fluctuations are less than near the surface (Licht 1971).

The eggs hatch in approximately 5 weeks (Brown 1975) with some variation in development time depending on water temperature: the warmer the water, the faster development occurs. Normal egg development occurs at temperatures from 4 to 20°C (Licht 1971). The hatchlings take at least 3–4 months to metamorphose (Licht 1974; Brown 1975); young of the year begin to emerge in late July/early August and continue emerging through early October (Calef 1973a). Larval developmental and growth rate may be altered by both biotic (e.g., presence of predators) and abiotic (e.g., water temperature) factors.

Survival of embryos can be high; Licht (1974) observed a 90% survival rate to hatching. However, like other anurans, larval survival to metamorphosis appears to be much lower, estimated at 5% (Licht 1974). The main source of mortality of developing larvae is likely predation (Licht 1974; Adams 2000).

Site fidelity

Limited information exists on movement patterns and site fidelity of Red-legged Frogs. One study showed that males had a tendency to return to the same breeding site (a particular part of a lake; Calef 1973b), and individuals may well show fidelity to particular breeding sites from year to year. It is not known whether adult frogs return to the same terrestrial foraging area following breeding.

Home range

Unknown.

Movements and dispersal

One study on northern Vancouver Island examined movements of radio-tagged Red-legged Frogs within logged landscapes. While most (up to ~ 80%) tagged frogs moved <10 m within a 24-hour period, some made long movements, demonstrating potential to move relatively long distances over short periods (Chan-McCleod et al. 2000). Chan-McCleod et al. (2000) observed movements >300 m within 24 hours. However, these movements were recorded for frogs that were displaced from their original point of capture, so it is unlikely that these observations represent typical daily movements within the home range. Nothing is known about dispersal ability of the frogs and movements to and from aquatic breeding sites.

Habitat

Structural stage

2c: aquatic herbaceous
3b: tall shrub
4: pole/sapling forest
5: young forest
6: mature forest
7: old forest

Important habitat and habitat features

Aquatic

Although Red-legged Frogs require standing water to breed, they can use a diversity of waterbodies and wetlands. Breeding sites exhibit a wide variation in size, water depth, degree of permanency, and community structure (Richter and Azous 1995; Adams 1999; Beasley et al. 2000). Low water flow and complexity of microhabitat within the wetlands appear to be important. For example, although Red-legged Frogs were present in all types of wetlands sampled on western Vancouver Island (including shallow open water, marsh, swamp, fen, and bog), the highest proportion of occurrence was in bogs and fens (Beasley et al. 2000). Bogs and fens are characterized by humus substrate (as opposed to rock), greater herbaceous and emergent vegetation, and submerged down wood, all of which provide structural habitat for tadpoles. Adams (1999) also found that wetlands with emergent vegetation were more likely to be occupied by Red-legged Frogs than those with more open water (i.e., <50% of wetland surface had emergent vegetation). The Red-legged Frog selects sites with thin-stemmed, emergent plants (e.g., rushes and sedges) for breeding (Storm 1960; Licht 1969; Richter and Azous 1995); therefore, microhabitat of increasing complexity appears to be important for the frogs. Red-legged Frogs are also associated with wetlands having low water flow (Storm 1960; Licht 1969; Bury 1988; Richter and Azous 1995). Briggs (1987) recorded eggs in water depths from 30 to 500 cm deep and at least 60 cm from the shoreline.

The presence of Red-legged Frogs in aquatic-breeding habitat does not appear to be associated with forest age. Beasley et al. (2000) surveyed a variety of wetlands on the west coast of Vancouver Island for the presence of aquatic-breeding amphibians. Red-legged Frogs were present in 32% (*n* = 11) of wetlands that were in logged and/or roaded areas and 24% (*n* = 27) of wetlands that were undisturbed in old-growth forest (Beasley et al. 2000). Although Red-legged Frogs used wetlands disturbed by harvesting and intersected by roads, it is unknown whether these sites produced sufficient offspring to ensure population viability or whether they acted as reproductive sinks.

Terrestrial

Terrestrial habitat is where a significant portion of feeding and growth occurs (up to 90% of the time). Despite this, what constitutes high versus low quality terrestrial habitat remains unknown. Red-legged Frog abundance has been found to be positively and negatively associated with a variety of terrestrial habitat components. These relationships are difficult to interpret in a biologically meaningful way; however, some patterns are beginning to emerge. Red-legged Frogs are negatively associated with elevation (Aubry and Hall 1991; Bury et al. 1991; Aubry 2000; Beasley et al. 2000) and slope (Bury et al. 1991; Aubry and Hall 1991). Flatter sites at lower elevation (i.e., below 500 m) are areas associated with standing water (Aubry and Hall 1991). They also tend to be more abundant in riparian areas compared with upslope (McComb et al. 1993; Gomez and Anthony 1996; Cole et al. 1997). Chan-McCleod et al. (2000) found that frogs radio-tracked in clearcuts on northern Vancouver Island were usually associated with streams. Therefore, proximity to water appears to be an important determinant of their distribution, especially in disturbed landscapes. Two other habitat components that may be important to Red-legged Frogs include deciduous forest (in the United States) and abundance of coarse woody debris. Gomez and Anthony (1996) found the highest abundance of Red-legged Frogs in deciduous forest compared with a variety of conifer stand ages including old growth. Red-legged Frog presence was also correlated with high amounts of coarse woody debris indicating this habitat element may be important for cover (Aubry and Hall 1991).

At the stand level, as long as there is forest cover, the age of the forest does not appear to be important in determining the distribution of Red-legged Frogs. The Red-legged Frog has been found in a range of forest stand ages and although it can be associated with old growth (Walls et al. 1992; Blaustein et al. 1995), it is not considered an old growth dependent species in the United States (SAT 1993). The abundance of the frogs varies greatly among sites (Bury and Corn 1988; Bury et al. 1991; Cole et al. 1997; Maxcy 2000), making it difficult to establish clear relationships with specific variables such as forest age, structure, and composition. In Washington State, Red-legged Frogs were 1.25 more abundant in successional forests (30–76 yr) compared with clearcuts (Bury and Corn 1988). In Oregon, they were 5–10 times more abundant in rotation age stands (50–70 yr) compared with younger age classes including clearcut sites (Aubry 2000). In southwestern British Columbia, Maxcy (2000) captured 11 frogs in a 70-year-old second-growth stand before harvesting and only one frog one year post-harvesting.

The spatial distribution of Red-legged Frogs is likely related more to proximity of suitable breeding habitat rather than forest age *per se* (Welsh and Lind 1988; Bury et al. 1991; Corn and Bury 1991). Although Red-legged Frogs have no apparent association with stand age, they do appear to be negatively affected by clearcutting and very young successional forest.

Conservation and Management

Status

The Red-legged Frog is on the provincial *Blue List* in British Columbia. It is designated as a species of *Special Concern* in Canada (COSEWIC 2002).

Summary of ABI status in BC and adjacent jurisdictions (NatureServe Explorer 2002)

BC	WA	OR	CA	Canada	Global
S3S4	S5?	S3	S2?	N?	G4

Note: Washington has an incorrect and conflicting rank with the global rank. State ranks can not be more secure (i.e., S5) than the global rank (G4).

Trends

Population trends

There is currently no information on population trends for Red-legged Frog populations in British Columbia (Waye 1999). Most historical localities from the province have not been visited recently. Since the 1970s, populations in the Willamette Valley in Oregon have declined severely (Blaustein and Wake 1990). Populations of the California subspecies (*R. aurora draytoni*) have declined drastically through their range (Hayes and Jennings 1986; Fisher and Shaffer 1996).

Habitat trends

There has been a significant loss of Red-legged Frog habitat in parts of its range in British Columbia. The Lower Mainland is the most populated area of the province. Since 1827, wetland area has decreased from 10 to 1% in the lower Fraser Basin ecosystem (Boyle et al. 1997). Over this same period, the area of coniferous forest declined from 71 to 54%, while urban and agriculture use increased by 26% (Boyle et al. 1997). Southern and eastern Vancouver Island have also become extensively urbanized and developed. Much of the forest in the interior of the island and north of Vancouver has been fragmented by logging, but the effects of this fragmentation on the Red-legged Frog are unknown.

Threats

Population threats

The introduction of exotic species has been suggested as one reason for the decline of ranid frogs in western North America, including Red-legged Frogs. Bullfrogs (*Rana catesbieana*) in particular have been implicated in these declines (Nussbaum et al. 1983; Hayes and Jennings 1986; Kiesecker and Blaustein 1997). However, results from recent studies indicate Red-legged Frog responses to introduced predators including bullfrogs and fish are not predictable (Keisecker and Blaustein 1997; Adams 2000).

Under experimental conditions (e.g., pond enclosures or aquaria), the larvae of the Red-legged Frog are adversely affected by the presence of both bullfrog larvae and adults. Larval microhabitat use can change (Kiesecker and Blaustein 1998), growth rates are lower, and time to metamorphosis may be shorter (Adams 2000) or longer (Kiesecker and Blaustein 1998); all these factors have potentially negative consequences to survival. Due to the lower growth rates, metamorphosis occurs at a smaller size, which has implications for subsequent survival. Survival may also be directly reduced in the presence of bullfrog larvae (Lawlor et al. 1999); however, this is not a predictable response and depends on other factors as well. For example, Keisecker and Blaustein (1997) found the survival of Red-legged Frog tadpoles was unaffected by bullfrog presence if the tadpoles originated from a population that was sympatric with bullfrogs in its natural setting but not if the tadpoles were from a native population. Survival of Red-legged Frog tadpoles alone with bullfrog tadpoles was unaffected but was reduced when bullfrog larvae were present with adult bullfrogs and/or predatory fish (Kiesecker and Blaustein 1998). Adams (2000) observed low survival rates of Red-legged Frog tadpoles across a number of treatments, which included the presence and absence of predators in temporary and permanent wetlands. He suggests tadpole survival within enclosures was related to the abundance of tadpoles outside enclosures, indicating that some other factor other than the presence of exotic species was influencing survival rate of Red-legged Frog tadpoles such as predation by invertebrate predators and/or food limitation. Although Red-legged Frog tadpoles have variable survival in the presence of bullfrog larvae, metamorphosing frog survival was <5% in the presence of adult bullfrogs (Kiesecker and Blaustein 1998), indicating terrestrial mortality may have a considerable effect on the number of successful metamorphs leaving the wetland.

While the presence of bullfrogs and exotic fish has been shown to negatively affect Red-legged Frogs in a number of ways, other factors have been found more important in determining the distribution of Red-legged Frogs at the landscape scale. For example, Adams (1999) found the distribution of Red-legged Frogs was more closely associated with habitat structure and the presence of fish than to the presence of bullfrogs. Richter and Azous (1995) sampled 19 wetlands and found Red-legged Frogs in 70% of the wetlands. Lower species richness in these wetlands was not correlated with the presence of exotic fish or bullfrogs, but rather increasing water-level fluctuation and percentage of watershed urbanization. While bullfrogs and fish can significantly impact Red-legged Frog populations, other factors may be more important in determining their abundance and distribution.

Another factor implicated in the decline of amphibians in the Pacific Northwest is increased ultraviolet (UV) radiation. However, for Red-legged Frogs, UV does not appear to be an issue. There were no significant differences in survival of Red-legged Frog eggs (Blaustein et al. 1996; Ovaska et al. 1997) or larvae (Ovaska et al. 1997) between treatments shielded from UV-B compared with those exposed to ambient levels. Furthermore, the activity of photolyase (an enzyme important in repairing UV-damaged DNA) was higher in Red-legged Frogs compared with many amphibians (Blaustein et al. 1996), indicating UV-B radiation is an unlikely mechanism in the decline for this species at present. However, under experimentally enhanced UV-B levels, eggs and larvae of the Red-legged Frogs were more sensitive than those of the sympatric Pacific Treefrog (*Pseudacris regilla*) and experienced high mortality.

Roads can have both direct population impacts, particularly when they cross important dispersal or migration routes and are heavily used (Fahrig et al. 1995), as well as indirect impacts through habitat alteration. Road mortality has been documented for this species and may be common in urban environments (Waye 1999). The impact to populations is not known.

Although the effect of toxic pollutants on the Red-legged Frog is not specifically known, agricultural pollutants have been shown to have mutagenic effects on amphibians (Bonin et al. 1997). There have been no known instances where disease was determined to negatively impact populations of *R. a. draytoni* (USFWS 1996).

Habitat threats

Habitat loss and degradation have been suggested as the primary causes of ranid declines (Corn 1994; Blaustein 1994).

The loss of wetlands in the lower Fraser Valley and on southern Vancouver Island to urbanization and agriculture has significantly reduced available breeding habitat, fragmented habitats, and reduced the quality of breeding habitats.

On Crown land, forest harvesting and road construction are likely one of the primary threats to Red-legged Frog habitat. Forest harvesting has been shown to affect many functions of wetlands including productivity, hydrology, species assemblage, and habitat (Richardson 1994). However, the degree to which functions are altered depends on a number of other factors such as type of harvesting used (e.g., partial cutting, clearcut), use of a buffer around the wetland, and size of the wetland. In British Columbia, harvesting practices have likely altered wetlands but the importance of this to Red-legged Frog populations is unknown.

At the local scale (i.e., individual wetlands), removing forest canopy increases the rate of evaporative water loss. A shoreline that recedes too early in the spring potentially strands eggs that are laid in the shallow margins, directly increasing mortality of eggs. Developing larvae may also be stranded if the wetland dries up before the tadpoles have had a chance to metamorphose. Protection around wetlands is also critical to metamorphosing frogs that have a high risk of desiccation due to their timing of metamorphosis during the hottest, driest times of the year, and high surface area to volume ratio (they lose water more quickly than do adults). Without suitable microclimates, the risk of mortality due to desiccation is greatly increased (Semlitsch 1998; DeMaynadier and Hunter 1999).

At larger scales (e.g., watershed scale), the loss of small wetlands can affect metapopulation dynamics of pond-breeding amphibians and increase the probability of extinction of populations in the remaining wetlands (Gibbs 1993, 2000; Semlitsch 1998). Although small wetlands do not comprise a large area in the land base, they are often numerically dominant to large wetlands. For example, Semlitsch and Bodie (1998) observed 46% of wetlands in the southeastern Atlantic coastal plain were <1.2 ha. Over 97% of all wetlands surveyed on the west side of Vancouver Island were <0.1 ha (Beasley et al. 2000); Red-legged Frogs were present in 26% of these wetlands. The loss of unclassified wetlands not only decreases the number of aquatic-breeding sites, reducing the abundance or density of organisms, it also increases the nearest neighbour distance between sites, impeding source-sink processes (Gibbs 1993, 2000; Semlitsch 1998). For a number of species of ranid frogs, the occupancy of wetlands is related to the proximity of other breeding ponds (Laan and Verboon 1990; Gulve 1994; Pope et al. 2000). These results suggest nearby population sources are important in maintaining metapopulations of pond-breeding amphibians. Little is known about the metapopulation dynamics of Red-legged Frogs but studies on other ranids suggest they may be important.

Legal Protection and Habitat Conservation

Under the provincial *Wildlife Act*, the Red-legged Frog is protected in that it cannot be killed, collected, or held in captivity without special permits.

Several sites occur in protected areas including: Little Campbell River Regional Park, Miracle Beach Provincial Park, Morrell Nature Sanctuary, Garibaldi Provincial Park, Strathcona Provincial Park, Stanley Park, Rithet's Bog Nature Sanctuary, Spectacle Lake Provincial Park, and Trevlac Municipal Park (Waye 1999).

Habitat conservation needs may be partially addressed under the results based code, particularly the riparian management recommendations. Although retention of buffers on streams and wetlands is likely beneficial to Red-legged Frogs, the regulations associated with the riparian management for wetlands are not at an appropriate scale to manage for Red-legged Frog breeding habitat. Additional protection is required for wetlands <0.5 ha that currently receive no protection.

The most critical component for terrestrial habitat is likely sufficient cover and, on a larger scale, connectivity and distance between wetlands to maintain metapopulation dynamics in the landscape. Connectivity of habitats is not explicitly addressed under the results based code but may occur through landscape level planning.

Since the range of the species overlaps with urban areas, urban planning and municipal provisions may also provide some protection.

Identified Wildlife Provisions

Sustainable resource management and planning recommendations

- Maximize connectivity of wetlands and riparian habitats considered to be of importance to this species (i.e., wetlands <850 m). Connectivity should be considered in terms of 1 km or less. A network of interconnected wetlands will increase connectivity and dispersal of juvenile frogs, possibly maintain metapopulation dynamics, and buffer against temporal variation in productivity of individual wetlands or stochastic events that may change a source population to a sink and vice versa.

Wildlife habitat area

Goal

Maintain aquatic and riparian breeding habitats not addressed by the *Riparian Management Area Guidebook* (e.g., non-classified wetlands <0.5 ha, ephemeral wetlands) or through landscape level planning. Over time, WHAs may need to be relocated to account for succession.

Feature

Establish WHAs at networks of small ephemeral or perennial wetlands (each <0.5 ha). A wetland network defined here is different from a wetland complex as defined in the riparian management recommendations. A wetland network is a general term that can include a wetland complex but also wetlands that are too small to be considered a complex (i.e., <5 ha total area) but are likely still important breeding habitat for Red-legged Frogs. A network should include at least three wetlands that are within 300 m of each other.

The priority for establishing WHAs should be those wetlands where Red-legged Frogs are known to occur regularly. Suitable sites are characterized by the following attributes: (1) high structural complexity within the wetland (i.e., high percent coverage of thin-stemmed emergent vegetation, coarse woody debris); (2) a humus substrate; (3) forest/vegetation cover surrounding wetland; (4) absence of vertebrate predators (fish and bullfrogs); (5) <850 m in elevation; (6) small size (<0.5 ha); and (7) capacity to hold water until the end of the summer (31 August).

Size

Generally, <10 ha but will depend on site-specific factors including the spatial arrangement of wetlands and size of wetlands.

Design

The WHA should include a core area that encompasses the wetland network plus a 30 m reserve of adjacent riparian habitat beyond the high watermark. The WHA should also include a 20 m management zone beyond the core area.

General wildlife measures

Goals

1. Prevent road mortality and mortality due to industrial activities during the breeding season (March–August).
2. Maintain as closely as possible the natural hydrological regime of wetlands.
3. Maintain the structural integrity of emergent vegetation to provide egg-laying sites and rearing habitat for developing tadpoles.
4. Maintain forest or vegetation cover adjacent to breeding sites to provide suitable microclimatic conditions for emerging juveniles and foraging adults.
5. Maintain important habitat features including natural levels of coarse woody debris, a deciduous component to stands where appropriate, and understorey vegetation surrounding wetlands.

Measures

Access

- Do not construct roads.

Harvesting and silviculture

- Do not harvest in the core area.
- In the management zone, use partial harvesting systems that maintain 70% basal area. Maintain forest structure and cover by retention of large diameter trees, multi-layered canopies, snags, and coarse woody debris. Retain as much understorey trees, shrubs, and herbaceous vegetation as is practicable.
- No salvage should be carried out.

Pesticides

- Do not use pesticides.

Additional Management Considerations

Consider installing culverts under roads with drift fences directed toward the culverts at selected locations on roads that have high traffic volume at night and where road mortality of Red-legged Frogs is high.

Prevent fish introductions and the spread of bullfrogs.

Information Needs

1. Determine population/distribution trends and the northern extent of the Red-legged Frog. Trends should be determined separately for the Vancouver Island and mainland populations.
2. Information on movement patterns of newly metamorphosed Red-legged Frogs, home ranges of terrestrial adults, and metapopulation dynamics is needed to determine the appropriate scale of Red-legged Frog WHAs (i.e., network of wetlands).
3. More information is needed on the effects of forest management on Red-legged Frogs, particularly with respect to aquatic-breeding habitats. Experimental designs should focus on the breeding site in conjunction with the surrounding upland habitat as experimental units.

Cross References

Keen's Long-eared Myotis, Pacific Water Shrew

References Cited

Adams, M.J. 1999. Correlated factors in amphibian decline: exotic species and habitat change in Western Washington. J. Wildl. Manage. 63:1162–1171.

_____. 2000. Pond permanence and the effects of exotic vertebrates on anurans. Ecol. Appl. 10:559–568.

Aubry, K.B. 2000. Amphibians in managed, second-growth Douglas-fir forests. J. Wildl. Manage. 64:1041–1052.

Aubry, K.B. and P.A. Hall. 1991. Wildlife and vegetation of unmanaged Douglas-fir forests. *In* Wildlife and vegetation of unmanaged Douglas-fir forests. L.F. Ruggiero, K.B. Aubry, A.B. Carey, and M.H. Huff (editors). U.S. Dep. Agric. For. Serv., PNW-GTR-285, pp. 326–338.

Beasley B., C. Addison, and K. Lucas. 2000. Clayoquot Sound amphibian inventory: Long Beach Model Forest Soc. Ucluelet, B.C. 67 p.

Blaustein, A.R. 1994. Chicken little or Nero's fiddle? A perspective on declining amphibian populations. Herpetologica 50:85–97.

Blaustein, A.R., J.J. Beatty, D.A. Olson, and R.M. Storm. 1995. The biology of amphibians and reptiles in old-growth forests in the Pacific Northwest. U.S. Dep. Agric. For. Serv., PNW-GTR-337. 98 p.

Blaustein, A.R., P.D. Hoffman, J.M. Kiesecker, and J.B. Hays. 1996. DNA repair activity and resistance to solar UV-B radiation in eggs of the Red-legged frog. Conserv. Biol. 10(5):1398–1402.

Blaustein, A.R. and D.B. Wake. 1990. Declining amphibian populations: a global phenomenon? Trends Ecol. Evol. 5(7):203–204.

Bonin, J., M. Ouellet, J. Rodrigue, and J.-L. DesGranges. 1997. Measuring the health of frogs in agricultural habitats subjected to pesticides. Herpetol. Conserv. 1:246–257.

Boyle, C.A., L. Lavkulich, H. Schreier, and E. Kiss. 1997. Changes in land cover and subsequent effects on lower Fraser Basin ecosystems from 1827 to 1990. Environ. Manage. 21(2):185–196.

Briggs, J.L.S. 1987. Breeding biology of the cascade frog, *Rana cascadae*, with comparisons to the *R. aurora* and *R. pretiosa*. Copeia 1987(1):241–245.

Brown, H.A. 1975. Reproduction and development of the Red-legged frog, *Rana aurora*, in Northwestern Washington. Northwest Sci. 49(4):241–252.

Bury, R.B. 1988. Habitat relationships and ecological importance of amphibians and reptiles. *In* Streamside management. Riparian wildlife and forestry interactions. K.J. Raedeke (editor). Univ. Wash., Inst. For. Res., Seattle, Wash., pp. 61–76.

Bury, R.B. and P.S. Corn. 1988. Douglas-fir forests in the Oregon and Washington Cascades: relations of the herptofauna to stand age and moisture. *In* Management of amphibians, reptiles and small mammals in North America. R.C. Szaro, K.E. Stevenson and D.R. Patton (editors). Proc. symp. July 19–21, 1988, Flagstaff, Ariz. pp. 11–22.

Bury, R.B., P.S. Corn, and K.B. Aubry. 1991. Regional patterns of terrestrial amphibian communities in Oregon and Washington. *In* Wildlife and vegetation of unmanaged Douglas-fir forests. L.F. Ruggiero, K.B. Aubry, A.B. Carey, and M.F. Huff (editors). U.S. Dep. Agric. For. Serv., Portland, Oreg., Gen. Tech. Rep. PNW-285, pp. 341–350.

Calef, G.W. 1973a. Natural mortality of tadpoles in a population of *Rana aurora*. Ecology 54:741–758.

_____. 1973b. Spatial distribution and "effective" breeding population of Red-legged Frogs (*Rana aurora*) in Marion Lake, British Columbia. Can. Field-Nat. 87:279–284.

Chan-McLeod, A., G. Sutherland, I. Houde, and F. Bunnell. 2000. Persistence of forest dependent vertebrates in managed forests. Unpubl. rep.

Cole, E.C., W.C. McComb, M. Newton, C.L. Chambers, and J.P. Leeming. 1997. Response of amphibians to clearcutting, burning, and glyphosate application in the Oregon Coast Range. J. Wildl. Manage. 61:656–664.

Committee on the Status of Endangered Wildlife in Canada (COSEWIC). 2002. Canadian Species at Risk. www.speciesatrisk.gc.ca

Corkran, C.C. and C. Thoms. 1996. Amphibians of Oregon, Washington, and British Columbia. Lone Pine Publishing, Vancouver, B.C.

Corn, P.S. 1994. What we know and don't know about amphibian deeclines in the West. *In* Sustainable ecological systems: implementing an ecological approach to land management. W.W. Covington and L.F. DeBano (editors). U.S. For. Serv., Fort Collins, Colo. pp. 59–67.

_____ 1994. What we know and don't know about amphibian declines in the West. *In* Sustainable ecological systems: implementing an ecological approach to land management. W.W. Covington and L.F. DeBano (editors). U.S. Dep. Agric., For. Serv., Fort Collins, Colo., pp. 59–67.

Corn, P.S. and R.B. Bury. 1991. Terrestrial amphibian communities in the Oregon Coast Range. *In* Wildlife and vegetation of unmanaged Douglas-fir forests. L.F. Ruggiero, K.B. Aubry, A.B. Carey, and M.F. Huff (editors). U.S. Dep. Agric. For. Serv., Portland, Oreg., Gen. Tech. Rep. PNW-285, pp. 305–317.

DeMaynadier, P.G. and M.L. Hunter, Jr. 1999. Forest canopy closure and juvenile emigration by pool-breeding amphibians in Maine. J. Wildl. Manage. 63(2):441–450.

Fahrig, L., J.H. Pedlar, S.E. Pope, P.D. Taylor, and J.F. Wegner. 1995. Effect of road traffic on amphibian density. Biol. Conserv. 73:177–182.

Fisher, R.N. and H.B. Shaffer. 1996. The decline of amphibians in California's Great Central Valley. Conserv. Biol. 10(5):1387–1397.

Gibbs, J.P. 1993. Importance of small wetlands for the persistence of local populations of wetland-associated animals. Wetlands 13(1):25–31.

_____. 2000. Wetland loss and biodiversity conservation. Conserv. Biol. 14(1):314–317.

Gomez, D.M. and R.G. Anthony. 1996. Amphibian and reptile abundance in riparian and upslope areas of five forest types in Western Oregon. Northwest Sci. 70:109–119.

Gulve, P.S. 1994. Distribution and extinction patterns within a northern metapopulation of pool frog, *Rana lessonae*. Ecology 75(5):1357–1397.

Hayes, M.P. and M.R. Jennings. 1986. Decline of Ranid frog species in Western North America: are bullfrogs (*Rana catesbeiana*) responsible? J. Herpetol. 20(4):490–509.

Kiesecker, J.M. and A.R. Blaustein. 1997. Population differences in reponses of Red-legged Frogs (*Rana aurora*) to introduced bullfrogs. Ecology 78:1752–1760.

_____. 1998. Effects of introduced bullfrogs and smallmouth bass on microhabitat use, growth, and survival of native Red-legged Frogs (*Rana aurora*). Conserv. Biol. 12:776–787.

Laan, R. and B. Verboon. 1990. Effects of pool size and isolation on amphibian communities. Biol. Conserv. 54:251–262.

Lawlor, S.P., D. Dritz, T. Strange, and M. Holyoak. 1999. Effects of introduced mosquitofish and bullfrogs on the threatened California Red-legged Frog. Conserv. Biol. 13(3):613–622.

Licht, L.E. 1969. Comparative breeding behavior of the Northern Red-legged Frog (*Rana aurora aurora*) and the western spotted frog (*Rana pretiosa pretiosa*) in southwestern British Columbia. Can. J. Zool. 47:1287–1299.

_____. 1971. Breeding habits and embryonic thermal requirements of the frogs, *Rana aurora aurora* and *Rana pretiosa pretiosa*, in the Pacific Northwest. Ecology 52:116–124.

_____. 1974. Survival of embryos, tadpoles, and adults of the frogs *Rana aurora aurora* and *Rana pretiosa pretiosa* sympatric in southwestern British Columbia. Can. J. Zool. 52:613–627.

_____. 1986. Food and feeding behavior of sympatric Red-legged Frogs, *Rana aurora*, and spotted frogs, *Rana pretiosa*, in southwestern British Columbia. Can. Field-Nat. 100(1):22–31.

Maxcy, K.A. 2000. The response of terrestrial salamanders to forest harvesting in southwestern British Columbia. M.Sc. thesis. Univ. B.C., Vancouver, B.C. 92 p.

McComb, W.C., K. McGarigal, and R.G. Anthony. 1993. Small mammal and amphibian abundance in streamside and upslope habitats of mature Douglas-fir stands, Western Oregon. Northwest Sci. 67:7–15.

NatureServe Explorer. 2002. An online encyclopaedia of life. Version 1.6. NatureServe. Arlington, VA. Available at http://www.natureserve.org/explorer/

Nussbaum, R.A., E.D. Brodie, Jr., and R.M. Storm. 1983. Amphibians and reptiles of the Pacific Northwest. Univ. Press Idaho, Moscow, Idaho. 332 p.

Ovaska K., T.M. Davis, and I.N. Flamarique. 1997. Hatching success and larval survival of the frogs *Hyla regilla* and *Rana aurora* under ambient and artificially enhanced solar ultraviolet radiation. Can. J. Zool. 75:1081–1088.

Pope, S.E., L. Fahrig, and H.G. Merriam. 2000. Landscape complementation and metapopulation effects on Leopard frog populations. Ecology 81(9):2498–2508.

Richardson, C.J. 1994. Ecological functions and human values in wetlands: a framework for assessing forestry impacts. Wetlands 14(1):1–9.

Richter, K.O. and A.L. Azous. 1995. Amphibian occurrence and wetland characteristics in the Puget Sound Basin. Wetlands 15(3):305–312.

Scientific Analysis Team (SAT). 1993. Viability assessments and management considerations for species associated with late-successional and old-growth forests of the Pacific Northwest. U.S. Dep. Agric. For. Serv. Res. National Forest System, Portland, Oreg. 530 p.

Semlitsch, R.D. 1998. Biological delineation of terrestrial buffer zones for pond-breeding salamanders. Conserv. Biol. 12:1113–1119.

Semlitsch, R.D. and J.R. Bodie. 1998. Are small, isolated wetlands expendable? Conserv. Biol. 12(5):1129–1133.

Storm, R.M. 1960. Notes on the breeding biology of the Northern Red-legged Frog (*Rana aurora aurora*). Herpetologica 16:251–259.

U.S. Fish and Wildlife Service (USFWS). 1996. Endangered and threatened wildlife and plants; determination of threatened status for the California red-legged frog. Federal Register 61(101):25813–25833.

Walls, S.C., A.R. Blaustein, and J.J. Beatty. 1992. Amphibian biodiversity of Pacific Northwest with special reference to old-growth stands. Northwest Environ. J. 8:53–69.

Waye, H.. 1999. Status report on the Northern red-legged frog, *Rana aurora*, in Canada. Report prepared for the Committee on the Status of Endangered Wildlife in Canada. Ottawa, Ont.

Welsh, H.H., Jr. and A.J. Lind. 1988. Old growth forests and the distribution of the terrestrial herpetofauna. *In* Management of amphibians, reptiles and small mammals in North America. R.C. Szaro, K.E. Severson, and D.R. Patton (editors). U.S. Dep. Agric. For. Serv., Gen. Tech. Rep. RM-166, pp. 439–458.

ROCKY MOUNTAIN TAILED FROG

Ascaphus montanus

Original prepared by Linda A. Dupuis

Species Information

Taxonomy

Phylogenetic studies have determined that tailed frogs belong in their own monotypic family, Ascaphidae (Green et al. 1989; Jamieson et al. 1993). Recent phylogeographic analysis has determined that coastal and inland assemblages of the tailed frog are sufficiently divergent to warrant designation as two distinct species: *Ascaphus truei* and *Ascaphus montanus* (Nielson et al. 2001). The divergence of coastal and inland populations is likely attributable to isolation in refugia in response to the rise of the Cascade Mountains during the late Miocene to early Pliocene (Nielson et al. 2001).

The Coastal Tailed Frog and Rocky Mountain Tailed Frog are the only members of the family Ascaphidae and are considered the most primitive frogs in the world, representing the basal lineage of the anurans (Ritland et al. 2000; Nielson et al. 2001).

Description

Tailed frogs have unique morphological adaptations to life in fast-flowing mountain streams. They are the only frog species in North America that breed in cold mountain streams. Adults are small (2.2–5.1 cm) with a large head, a vertical pupil, and broad and flattened outer hind toes. They lack tympana (ear membranes) and the ability to vocalize, presumably adaptations to the constant sound of rushing water. The species is commonly known as the Tailed Frog because males have a short, conical "tail" with which to inseminate females. Adults have a grainy skin that can vary in colour from tan, to chocolate brown, to olive green (Metter 1964a; Dupuis, pers. obs.); fine black speckling generally occurs on paler individuals. There is often a distinct copper bar or triangle between the eyes and snout, with green undertones (Metter 1964a).

Tadpoles are roughly 11 mm in length upon hatching, and can reach up to 65 mm long prior to metamorphosis (Brown 1990). They possess a wide flattened oral disc modified into a suction mouth for clinging to rocks in swift currents and grazing periphyton (Metter 1964a, 1967; Nussbaum et al. 1983), a ventrally flattened body, and a laterally compressed tail bordered by a low dorsal fin. They are black or light brownish-grey, often with fine black speckling; lighter flecks may or may not be present (Dupuis, pers. obs.). The tadpoles usually possess a white dot (ocellus) on the tip of the tail and often have a distinct copper-coloured bar or triangle between the eyes and snout. Hatchlings lack pigmentation, and are most easily characterized by the large, conspicuous yolk sac in the abdomen.

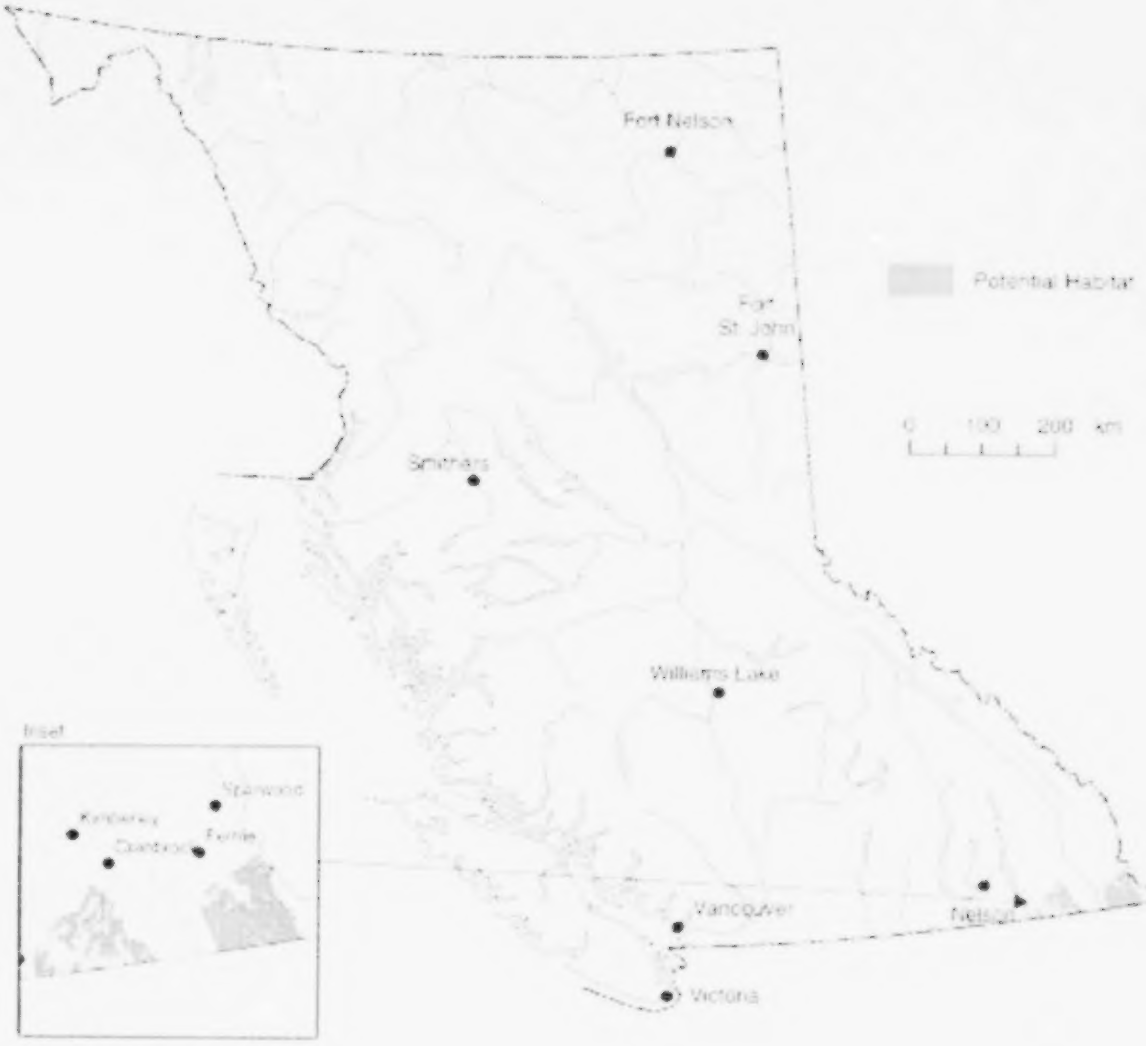
Distribution

Global

The Rocky Mountain Tailed Frog is endemic to the Pacific Northwest and occurs in the Blue Mountains of southeast Washington (Metter 1964a; Pauken and Metter 1971; Bull 1994), the Wallowa Mountains of northeast Oregon (Ferguson 1952; Bull and Carter 1996), central Idaho and the panhandle (Linsdale 1933; Corbit 1960; Maughan et al. 1980), the Columbia Ranges and Rocky Mountain Foothills of southeastern British Columbia (Dupuis and Wilson 1999), and the mountains east of western Montana's Bitterroot Ranges (Smith 1932; Franz and Lee 1970). Historically, at least one population was found on the eastern slopes of the Rocky Mountains (Donaldson 1934).

Rocky Mountain Tailed Frog

(Ascaphus montanus)


Fort Nelson
Potential Habitat
Fort St. John
0 100 200 km
Smithers
Williams Lake
Inset
Sparwood
Kimberley
Fernie
Cranbrook
Vancouver
Nelson
Victoria

Note: This map represents a broad view of the distribution of potential habitat used by this species. The map is based on several ecosystem classifications (Ecoregion, Biogeoclimatic and Broad Ecosystem Inventory) as well as current knowledge of the species' habitat preferences. This species may or may not occur in all areas indicated.

British Columbia

The Rocky Mountain Tailed Frog was first identified in the Southern Interior Mountains Ecoprovince in 1958 (Grant 1961). This occurrence was confirmed in the 1980s, but no official surveys were conducted until 1996 (Dupuis and Bunnell 1997; Dupuis and Wilson 1999). Based on these studies, there appears to be two separate populations: one in the Columbia Ranges and one in the Rocky Mountain Foothills. All known occurrences were within 20 km of the U.S. border (*n* = 190 creeks; Dupuis and Wilson 1999). The Columbia Ranges population is clustered within the Yahk River watershed, west of Yahk Mountain. In the Flathead, tailed frogs occur throughout the Couldrey, Cabin, Burnham, Storm, North Fork of the Bighorn and South Fork of Leslie drainages (Dupuis, pers. obs.).

Forest region and district

Southern Interior: Rocky Mountain

Ecoprovinces and ecosections

SIM: FLV, MCR, SPM

Biogeoclimatic unit

ESSF: wm
ICH: mk1, mw2
MS: dk

Broad ecosystem unit

EF (on steep south-facing slopes), AV, WR

Elevation

1190–1905 m

Life History

Diet and foraging behaviour

Adults and post-metamorphs emerge at dusk and during the night, to feed terrestrially on small arthropods within the riparian borders of streams (Metter 1964a, 1967). The diet consists primarily of spiders but other food items include Diptera (flies) and adult Trichoptera (caddisflies), Coleoptera (beetles), Lepidoptera (butterflies and moths), Hymenoptera (sawflies, ichneumons, chalcids, ants, wasps, bees), snails, ticks, mites, and crickets (Metter 1964a; Held 1985). The kinematics of prey capture in *Ascaphus* species have been described by several authors (Nishikawa and Cannatella 1991; Nishikawa and Roth 1991; Deban and Nishikawa 1992).

Tadpoles graze as they cling to gravel surfaces with their suctorial mouthparts. They consume primarily diatoms (non-filamentous algae), as well as some desmids and filamentous algae (Metter 1964a; Franz 1970b). Large amounts of pollen can be found in the intestines of larvae in the spring (Metter 1964a). It is expected that foraging opportunities for larvae are high during the summer months when productivity of algae is at its peak, and that larvae use this time to store fat for the coming winter.

Reproduction

The Rocky Mountain Tailed Frog does not reach reproductive maturity until 7 or 8 years of age (Daugherty and Sheldon 1982a) and females appear to breed every other year (Metter 1964a). In early fall, adults aggregate in the breeding creeks. Relatively high concentrations of adults have been noted in the upper reaches of breeding streams, and not in the lower reaches (T. Antifeau, pers. comm; P. Davidson, pers. comm.) during this time (August and September). Unlike most frog species, the males fertilize the eggs internally and females retain sperm until the following summer, ovipositing after spring runoff (Gaige 1920; Metter 1964b; Franz 1970a; Daugherty and Sheldon 1982a). Eggs are deposited in double strands of colourless, pea-sized ova attached to the downstream undersides of rocks (Metter 1964b; Franz 1970a; Daugherty and Sheldon 1982a; Nussbaum et al. 1983; Leonard et al. 1993), in deep pools. Tailed frogs have the largest eggs of all North American frogs (Wright and Wright 1949), and the longest embryonic period, varying from 3 to 6 weeks depending on the climate (Noble and Putnam 1931; Metter 1964a, 1967; Franz 1970a; Brown 1990).

Free-swimming larvae emerge in late August to early September (Metter 1964a; Franz 1970a). Hatchlings overwinter at the egg-laying site (Metter 1964a), feeding on the yolk sac until the following spring, when their suctorial mouth is fully developed (Brown 1990). Stream residency lasts from 1 to

5 years for *Ascaphus* species (Metter 1964a, 1967; Daugherty and Sheldon 1982a; Brown 1990; Bury and Corn 1991; Gray 1992; Bull and Carter 1996; Wahbe 1996; Wallace and Diller 1998; Bury and Adams 1999). Larval size-frequency patterns suggest a 3- to 4-year larval period for *A. montanus* (Daugherty and Sheldon 1982a). The rate of development may be related to the length of the growing season (Bury and Adams 1999), which is influenced by aspect, gradient, elevation, snowpack, and frost-free days (see Dupuis 1999). Metamorphosis occurs in late summer.

Site fidelity and home range

In Montana, breeding adults are highly sedentary, remaining in a 20 m stream segment for several years (Daugherty and Sheldon 1982b). Daugherty (1979) reported very little within- or between-stream movement of adults, and suggested that the species' recolonization potential is low. Metter (1964a) found *A. montanus* at a maximum distance of 12 m from the water's edge. Remaining near streams and maintaining small territories are likely selective advantages for securing food, mates, and shelter in the otherwise dry, inhospitable environment (Daugherty and Sheldon 1982b).

Movement and dispersal

Movements directly after metamorphosis have not been well documented. *Ascaphus* populations are remarkably discrete. They show strong genetic differences among streams (Ritland et al. 2000; Nielson et al. 2001), implying low movement potential. Daugherty and Sheldon (1982b) recorded a maximum dispersal distance of 360 m/yr for a juvenile female. Adults, especially males, disperse upstream. In the Yahk River, males were encountered 2.5:1 more than females in 1st order streams, but sex ratio was equal in 2nd and 3rd order streams (Dupuis and Friele 2002).

Habitat

Structural stage

7: old forest (>140 years)
6: mature forest (100–140 years)

Important habitats and habitat features

The presence of sedimentary or metamorphic sedimentary bedrock formations, moderate annual rainfall with a relatively high proportion of it occurring during the summer, and watersheds with low or moderate previous levels of harvest appear to be large-scale regional features in predicting the presence of tailed frogs (Wilkins and Peterson 2000). The main limitation, especially in the Flathead, is cold summer stream temperatures.

Terrestrial

Little work has been done on post-metamorphic and adult habitat associations. Tadpole-bearing creeks flow through young, mature, and old forests with structurally complex riparian zones (Franz and Lee 1970; Dupuis and Wilson 1999). A well-developed overstorey and understorey can help maintain high humidity and low temperatures (Franz and Lee 1970).

Forested riparian buffers benefit tailed frog larvae not only by moderating stream temperatures, but also by maintaining bank stability and channel characteristics (Kelsey 1995; Dupuis and Friele 1996; Dupuis and Steventon 1999). A rapid decline in the number of fine roots after trees are felled, and a sharp decrease in the tensile strength of the remaining roots, can reduce the strength of the soil mantle to the point of failure (Beschta 1978). The resulting sediment inputs to streams degrade habitat carrying capacity by increasing bedload movement and reducing interstitial refugia and foraging areas. Riparian buffers are particularly important for the Rocky Mountain Tailed Frog because the creeks in extreme southeast British Columbia have fractured and brittle bedrock, resulting in high bedload transport (see Dupuis and Wilson 1999). In addition, there appears to be strong fidelity to riparian habitats (Daugherty and Sheldon 1982b; Dupuis and Friele 2002).

Aquatic

Primary breeding habitats are step-pools of permanent mountain streams and headwaters (Dupuis 1999). Pool-riffle habitats characteristic of more gentle, fish-bearing streams, and cascade-pool habitats, where permanent boulder/log constrictions are created within a channel may also be used (see Chin 1989; Grant et al. 1990).

In the Flathead, streams between 10–16°C in the summer were most productive. In the northern interior, cold summer temperatures limit growth and development. Eggs require temperatures between 5 to 18.5°C for survival (Brown 1975). Incipient lethal water temperatures for adults range from 22°C (Metter 1966) to 24.1°C (Claussen 1973).

Larvae reach highest densities in warmer streams with stable, coarse gravel substrates (Dupuis and Friele 1996; Diller and Wallace 1999; Wilkins and Peterson 2000). Stable mountain streams are characterized by regularly spaced pools and interlocked cobble/boulder (or wood) steps that withstand moderate floods and sediment pulses (Chin 1998). An open-framework of boulders and cobbles between steps provides interstitial refugia to the tadpoles as well as stable egg-laying and overwintering sites. Conversely, sand and pebble substrates offer little shelter and foraging opportunities, and are generally avoided by tailed frog tadpoles (Franz and Lee 1970; Altig and Brodie 1972; Welsh 1993; Dupuis and Friele 1996; Welsh and Ollivier 1998).

Dupuis and Friele (2002) found that primary breeding streams were characterized by 1–10 m^3/s discharge, good summer base flow, gradients between 3 and 20%, stable, step-pool channel morphology, and summer temperatures between 10 and 16°C.

Conservation and Management

Status

The Rocky Mountain Tailed Frog is on the provincial *Red List* in British Columbia. It is designated as *Endangered* in Canada (COSEWIC 2002).

Summary of ABI status in BC and adjacent jurisdictions (NatureServe Explorer 2002)

BC	ID	MT	OR	WA	Canada	Global
S1	S3	S4	S2S3	S?	N1	G4

Trends

Population trends

Currently, the total population size of *Ascaphus* is unknown (Dupuis et al. 2000; Dupuis and Friele 2002). Most data on densities and abundances are based on in-stream (larval) surveys. Three key uncertainties prevent good estimates of *Ascaphus* population sizes: (1) fundamental demographic characteristics–especially survival rates; (2) area and carrying capacity of aquatic and adjacent riparian habitats; and (3) among-year and among-site variability (Sutherland et al. 2001). There is high, natural variability in tailed frog abundance within and among streams, governed in part by habitat characteristics and natural disturbance regimes (floods, sediment pulses, drought).

The Rocky Mountain Tailed Frog occurs in 10 tributaries in the Rocky Mountain Foothills (12 records) and 6 tributaries of the Columbia Ranges (7 records). Subpopulations are isolated from one another by the dry climatic conditions of the surrounding habitat matrix, particularly in the Columbia Ranges. The Rocky Mountain Tailed Frog may be threatened with imminent extirpation not only because of this isolation and the lengthy larval stage, low reproductive rate, and specialized habitat needs characteristic of *Ascaphus* species, but because of the low level of legal protection, threat of drought (global climate change), and the suboptimal nature of breeding habitats in the East Kootenays (Dupuis et al. 2000). Poor habitat quality is reflected in larval densities: area-constrained searches conducted in the late 1990s averaged 0.8 individuals/m^2 in the interior compared with 1.5 individuals/m^2 on the Coast (Dupuis and Wilson 1999; Dupuis et al. 2000).

Habitat trends

Suitable habitat is likely declining in British Columbia. Rocky Mountain Tailed Frog adults are largely dependent on riparian habitats adjacent to breeding sites because of the harsh thermal contrast between stream and upslope habitats in the interior. Whether non fish bearing streams are buffered depends on forestry operational constraints and professional discretion.

The Yahk watershed, where tailed frogs occur, has been altered by fire and forest harvesting (80–85% cover <100 years of age), and road densities are high (Dupuis and Friele 2002). Changes to the natural hydrological regime could have occurred and altered the habitats of tailed frogs. However, the extent of change is not known.

Threats

Population threats

Rocky Mountain Tailed Frog populations are at risk due to a restricted range (3 km radius in Columbian Ranges, 5 km radius in Border Ranges), geographic isolation, low number of occurrences (19), and low densities (0.78 ± 0.23 tadpoles/m^2). The Rocky Mountain Tailed Frog also exhibits a high level of genetic drift and possible declines in fitness (Ritland et al. 2000; Nielson et al. 2001). Reduced genetic diversity indicates that the species may have a limited capacity to migrate in response to changing conditions.

Habitat threats

Streams in the Flathead and Columbia mountains of Canada are generally underlain with brittle, metasedimentary rocks; as a result, they contain a large proportion of fractured bedrock as mobile bedload (Dupuis and Wilson 1999; Dupuis and Friele 2002). Unstable streams such as these are vulnerable to degradation following road building and timber harvesting activities. Road building and timber harvesting can increase the frequency and magnitude of sediment input to channel beds (Beschta 1978; Reid and Dunne 1984). The addition of woody debris to the channel can increase the risk of logjams, which trap fine sediments and alter a gully's substrate composition. Clearcut logging can also alter the hydrological regime of a watershed and accentuate peak discharges and low summer flows (Jones and Grant 1996). Several studies have reported declines in tailed frog tadpole populations following clearcut logging (Noble and Putnam 1931; Bury and Corn 1988; Corn and Bury 1989; Bury et al. 1991; Welsh and Lind 1991). In British Columbia, Dupuis and Steventon (1999) found that Coastal Tailed Frog tadpole densities were significantly lower in clearcut streams than in buffered or undisturbed streams of the north coast. Unstable streams like those within the range of the Rocky Mountain Tailed Frog in Canada are particularly vulnerable to degradation following timber-harvesting activities (Dupuis and Friele 1996).

In addition, the climate in the interior is harsh (Dupuis et al. 2000). Debris torrents, sediment floods, summer aridity, and cool summer stream temperatures probably play a significant role in local extinction and recolonization processes (Lamberti et al. 1991).

Legal Protection and Habitat Conservation

The Rocky Mountain Tailed Frog is protected, in that it cannot be killed, collected or held in captivity without special permits, under the provincial *Wildlife Act*. If salmonid habitat exists downstream, some level of protection may be provided through the *Fisheries Act*.

No populations occur within a protected area.

The results based code may provide protection through the establishment of old growth management areas (OGMAs) provided these overlap with known sites or suitable habitat. In addition, riparian management guidelines provide a measure of protection for riparian habitats, particularly for streams with game fish. However, since most populations of the Rocky Mountain Tailed Frog are found in small streams without fish, they are not protected by FRPA riparian management recommendations. These recommendations do not recommend retention of a riparian reserve zone on small streams where "game" fish are not present. However, they do recommend that forest practices in management zones adjacent to streams classified as S4–S6 (small fish or non fish bearing) be planned and implemented to meet riparian objectives. These objectives can include retaining sufficient vegetation to provide shade, reduce microclimatic changes, maintain bank stability and, where specified, may include objectives for wildlife, fish habitat, channel stability, and downstream water quality.

Identified Wildlife Provisions

Sustainable resource management and planning recommendations

In landscapes or those portions of landscapes (i.e., catchment areas for streams with tailed frogs) documented to contain tailed frog populations consider the following recommendations:

- Wherever appropriate use OGMAs to protect known tailed frog occurrences and suitable riparian habitats.
- Maximize connectivity of riparian habitats, particularly between WHAs and adjacent stream reaches.
- Increase retention on streams classified as S5 or S6 to maintain thermal conditions.
- Minimize use of chemical applications (e.g., dust-palliative polymer stabilizers and soil binders that can be sprayed within ditch lines).
- Minimize site disturbance during harvesting, especially in areas with high sediment transfer potential to natal streams.
- Fall and yard away from, or bridge, stream channels (ephemeral or perennial) to reduce channel disturbance and slash loading.
- Consider both the risk of desiccation and risk of sedimentation when determining size of cutblocks. Larger blocks can be accessed and yarded with a less dense road system, thus decreasing the potential sedimentation impacts but may have a greater impact on summer flows by having a more significant effect on the clearcut equivalent ratio and by increasing the wind fetch on streamside buffers. However, where desiccation is of greater concern, smaller block sizes may be more appropriate. Sedimentation risk may be offset by incorporating careful road planning and maintenance as described below.
- Construct narrow roads to minimize site disturbance and reduce groundwater interception in the cutslope and deactivate roads but minimize digging and disturbance to adjacent roadside habitat.
- Maintain naturally dispersed water flows (seepages, non-classified drainages and streams should be supplied with cross-drainage structures where crossed by roads).
- Use sediment-control measures in cut-and-fill slopes (e.g., grass-seeding, armouring ditch lines, and culvert outfalls).
- Develop a plan to consider issues of hydrological green-up and runoff response.

Wildlife habitat area

Goal

Maintain and link tailed frog streams and breeding areas.

Feature

Establish WHAs at streams that are characterized by (1) presence of tadpoles or adults; (2) year-round stream flow (i.e., perennial streams); (3) low to moderate gradients (<50%); (4) coarse gravel substrates (cobbles and boulders); (5) stable channel beds; and (6) forest cover. WHAs should be established in the headwaters of Cabin Creek, Couldrey Creek, and Yahk River (west of Yahk Mountain).

Size

Typically 100 ha (range 50–150 ha) but will ultimately depend on site-specific factors including the number and length of streams included and terrain stability.

Design

Ideally, the WHA should include several interconnected stream reaches (S4–S6) with evidence of presence of tailed frogs. The boundaries of a WHA should be designed to maintain stream conditions (substrate, temperature, macro-invertebrate, and algae communities) and connectivity between streams. The WHA should include a core area that extends 30 m from the water's edge on both sides and a 20 m management zone surrounding the core area.

General wildlife measures

Goals

1. Maintain clean and stable cobble/boulder gravel substrates, natural step-pool channel morphology, and stream temperatures within tolerance limits.
2. Maintain microclimatic, hydrological, and sedimentation regimes to (1) limit the frequency of occurrence of extreme discharge events, (2) limit the mortality rate of tailed frogs during floods, and (3) meet foraging and dispersal requirements of the adults and metamorphs.
3. Maintain riparian forest.
4. Maintain important structural elements (e.g., coarse woody debris).
5. Maintain water quality and naturally dispersed water flows.

Measures

Access

- Minimize roads or stream crossings within the core area. When stream crossings are determined to be necessary, use cross-drainage structures particularly bridges or open-bottomed culverts and ensure type of crossing structure and any associated roads are designed and installed in a manner that minimizes impacts to tailed frog instream and riparian habitats. When roads are determined to be necessary, minimize length and construct narrow roads to minimize site disturbance and reduce groundwater interception in the cutslope; use sediment-control measures in cut-and-fill slopes (e.g., grass-seeding, armouring ditch lines, and culvert outfalls); deactivate roads but minimize digging and disturbance to adjacent roadside habitat; minimize site disturbance during harvesting, especially in terrain polygons with high sediment transfer potential to natal streams; and fall and yard away from, or bridging, all other stream channels (ephemeral or perennial) within the WHA, to reduce channel disturbance and slash loading.

Harvesting and silviculture

- Do not harvest within the core area.
- No salvage should be carried out.
- In the management zone, use partial harvesting systems that maintain at least 70% basal area with the appropriate structure necessary to achieve the goals of the GWM.
- Wherever possible and practicable, augment management zone using wildlife tree retention areas.
- Do not use chemical applications (e.g., dust-palliative polymer stabilizers and soil binders that can be sprayed within ditch lines).

Pesticides

- Do not use pesticides.

Range

- Control livestock use. Fencing may be required by the statutory decision maker to achieve goals.

Additional Management Considerations

Manage stream reaches adjacent to WHA according to the recommended riparian management "best management practices." Where livestock grazing occurs follow the "target conditions for range use in stream riparian areas" from riparian management recommendations.

In extensively developed areas, management of the WHA should focus on channel restoration including channel and gully assessments, in-stream work to restore step-pool morphology and reduce sediment transport, stream-side planting to stabilize banks, and road deactivation to reduce sediment inputs.

Prevent fish introductions and rechannelization of areas supporting tailed frog populations.

Maintain slash-free headwater creeks and forested riparian buffers, especially within fragmented areas.

On S5 and S6 streams containing tailed frogs, retain structure especially on south side of east–west or west–east flowing streams to shade streams.

Information Needs

1. Detailed description of larval distribution and abundance within documented streams of occurrence; resurvey Gilnockie Creek drainage.

2. Channel assessment and habitat suitability ranking for tadpole-bearing creeks.
3. Age-specific movement/dispersal patterns and requirements of adults and post-metamorphs.

Cross References

Grizzly Bear, Williamson's Sapsucker (*nataliae* subspecies), Wolverine

References Cited

Altig, R. and E.D. Brodie, Jr. 1972. Laboratory behavior of tailed frog *Ascaphus truei* tadpoles. J. Herpetol. 6(1):21–24.

Beschta, M. 1978. Long-term patterns of sediment production following road construction and logging in the Oregon Coast Range. Water Resour. Res. 14(6):1011–1016.

Brown, H.A. 1975. Temperature and development of the tailed frog, *Ascaphus truei*. Comp. Biochem. Physiol. 50:397–405.

_____. 1990. Morphological variation and age-class determination in overwintering tadpoles of the tailed frog, *Ascaphus truei*. J. Zool. (London) 220:171–184.

Bull, E.L. 1994. Tailed frogs in the Blue Mountains. Northwest Sci. 68(2):23.

Bull, E.L. and B.E. Carter. 1996. Tailed frogs: distribution, ecology, and association with timber harvest in northeastern Oregon. U.S. Dep. Agric. For. Serv., Pac. Northwest Res. Stn., PNW-RP-497. 12 p.

Bury, R.B. and M.J. Adams. 1999. Variation in age at metamorphosis across a latitudinal gradient for the tailed frog, *Ascaphus truei*. Herpetologica 55(2):283–291.

Bury, R.B. and P.S. Corn. 1988. Responses of aquatic and streamside amphibians to timber harvest: a review. *In* Streamside management: riparian wildlife and forestry interactions: Proc. symp. K.J. Raedeke (editor). Feb. 11–13, 1987. Univ. Wash., Inst. For. Resour., Seattle, Wash., pp. 165–181.

_____. 1991. Sampling methods for amphibians in streams in the Pacific Northwest. U.S. Dep. Agric. For. Serv., Portland, Oreg., Gen. Tech. Rep. PNW-275.

Bury, R.B., P.S. Corn, K.B. Aubry, F.F. Gilbert, and L.L.C. Jones 1991. Aquatic amphibian communities in Oregon and Washington. *In* Wildlife and vegetation of unmanaged Douglas-fir forests. L.F. Ruggiero, K.B. Aubry, A.B. Carey, and M.H. Huff (editors). U.S. Dep. Agric. For. Serv., Pac. Northwest Res. Stn., Olympia, Wash., PNW-GTR-285, pp. 353–362.

Chin, A. 1989. Step-pools in stream channels. Prog. Phys. Geogr. 13:391–408.

_____. 1998. On the stability of step-pool mountain streams. J. Geol. 106:59–69.

Claussen, D.L. 1973. The water relations of the tailed frog, *Ascaphus truei*, and the Pacific treefrog, *Hyla regilla*. Comp. Biochem. Physiol. 44A:155–171.

Committee on the Status of Endangered Wildlife in Canada (COSEWIC). 2002. Canadian Species at Risk. www.speciesatrisk.gc.ca

Corbit, C.D. 1960. Range extension of *Ascaphus truei* in Idaho. Copeia 1960:240.

Corn, P.S. and R.B. Bury. 1989. Logging in western Oregon: responses of headwater habitats and stream amphibians. For. Ecol. Manage. 29:39–57.

Daugherty, C.H. 1979. Population ecology and genetics of *Ascaphus truei*: an examination of gene flow and natural selection. Ph.D. thesis. Univ. Mont., Missoula, Mont. 143 p.

Daugherty, C.H. and A.L. Sheldon. 1982a. Age-determination, growth, and life history of a Montana population of the tailed frog (*Ascaphus truei*). Herpetologica 38(4):461–468.

_____. 1982b. Age-specific movement patterns of the tailed frog *Ascaphus truei*. Herpetologica 38(4):468–474.

Deban, S.M. and K.C. Nishikawa. 1992. The kinematics of prey capture and the mechanism of tongue protraction in the green tree frog *Hyla cinerea*. J. Exp. Biol. 170(0):235–256.

Diller, L.V. and R.L. Wallace 1999. Distribution and habitat of *Ascaphus truei* in streams on managed, young growth forests in North Coastal California. J. Herpetol. 33:71–79.

Donaldson, L.R. 1934. The occurrence of *Ascaphus truei* east of the continental divide. Copeia 1934:184.

Dupuis, L. and D. Steventon. 1999. Riparian management and the tailed frog in northern coastal forests. For. Ecol. Manage. 124:35–43.

Dupuis, L. and K. Wilson. 1999. Status, distribution, and management needs of the tailed frog in the east Kootenays. B.C. Min. Environ., Lands and Parks, Nelson, B.C. Unpubl. rep. 19 p.

Dupuis, L.A. 1999. Status report on the Tailed Frog, *Ascaphus truei*, in Canada. Final rep. prepared for COSEWIC. 26 p.

Dupuis, L.A. and F.L. Bunnell. 1997. Status and distribution of the Tailed Frog in British Columbia. Final report for Forest Renewal BC. Univ. B.C., Cent. Appl. Conserv. Biol., Vancouver, B.C. 50 p.

Dupuis, L.A., F.L. Bunnell, and P.A. Friele. 2000. Determinants of the tailed frog's range in British Columbia. Northwest Sci. 74(2):109–115.

Dupuis, L.A. and P.A. Friele. 1996. Riparian management and the tailed frog. Interim report prepared for B.C. Min. For., Prince Rupert For. Reg., Smithers, B.C. 18 p.

_____. 2002 Distribution of *Ascaphus montanus* in the Yahk River and neighbouring watersheds. Forest Renewal BC/Min. Sustain. Res. Manage. and Columbia Fish and Wildl., Victoria, BC. Compensation Program report.

Ferguson, D.E. 1952. The distribution of amphibians and reptiles of Wallowa County, Oregon. Herpetologica 8:66–68.

Franz, R. 1970a. Egg development of the tailed frog under natural conditions. Bull. Maryland Herpetol. Soc. 6(2):27–30.

_____. 1970b. Food of larval tailed frogs. Bull. Maryland Herpetol. Soc. 6(3):49–51.

Franz, R. and D. Lee. 1970. The ecological and biogeorgraphical [*sic*] distribution of the tailed frog, *Ascaphus truei*, in the Flathead River drainage of northwestern Montana. Bull. Maryland Herpetol. Soc. 6:62–73.

Gaige, H.T. 1920. Observations upon the habits of *Ascaphus truei* Stejneger. Occas. Pap. Mus. Zool., Univ. Mich. 84:1–11.

Grant, G.E., F.J. Swanson, and M.G. Wolman. 1990. Pattern and origin of stepped-bed morphology in high-gradient streams, western Cascades, Oregon. Geol. Soc. Am. Bull. 102:340–352.

Grant, J. 1961. The tailed toad in southeastern British Columbia. Can. Field-Nat. 75:165.

Gray, L.A. 1992. Larval growth and age at completion of metamorphosis of the tailed frog, *Ascaphus truei*. M.Sc. thesis. Central Wash. Univ., Ellensburg, Wash. 62 p.

Green, D.M., T.F. Sharbel, R.A. Hitchmough, and C.H. Daugherty. 1989. Genetic variation in the genus *Leiopelma* and relationships to other primitive frogs. J. Zool. Syst. Evol. Res. 27(1989):65–79.

Held, S.P. 1985. Maintenance, exhibition, and breeding of the tailed frog, *Ascaphus truei*, in a zoological park. Herpetol. Rev. 16(2):48–51.

Jamieson, B., M. Lee, and K. Long. 1993. Ultrastructure of the spermatozoon of the internally fertilizing frog *Ascaphus truei* (Ascaphidae: Anura: Amphibia) with phylogenetic considerations. Herpetologica 49(1):52–65.

Jones, J.A. and G.E. Grant. 1996. Peak flow responses to clearcutting and roads in small and large basins, western Cascades Oregon. Water Resour. Res. 32(4):959–974.

Kelsey, K.A. 1995. Responses of headwater stream amphibians to forest practices in western Washington. Dissertation. Univ. Wash., Coll. For. Resour., Wildl. Sci., Seattle, Wash. 167 p.

Lamberti, G.A., S.V. Gregory, L.R. Ashkenas, R.C. Wildman, and K.M.S. Moore. 1991. Stream ecosystem recovery following a catastrophic debris flow. Can. J. Fish. Aqua. Sci. 48:196–208.

Leonard, W.P., H.A. Brown, L.L.C. Jones, K.R. McAllister, and R.M. Storm. 1993. Amphibians of Washington and Oregon. Seattle Audubon Soc., Seattle, Wash.

Linsdale, J.M. 1933. Records of *Ascaphus truei* in Idaho. Copeia 1933:223.

Maughan, O.E., P. Laumeyer, R.L. Wallace, and M.G. Wickham 1980. Distribution of the tailed frog, *Ascaphus truei* Stejneger, in several drainages in north central Idaho. Herpetol. Rev. 11:15–16.

Metter, D.E. 1964a. A morphological and ecological comparison of two populations of the tailed frog, *Ascaphus truei* Stejneger. Copeia 1964:181–195.

_____. 1964b. On breeding and sperm retention in *Ascaphus*. Copeia 1964:710–711.

_____. 1966. Some temperature and salinity tolerances of *Ascaphus truei* Stejneger. J. Idaho Acad. Sci. 4:44–47.

_____. 1967. Variation in the ribbed frog *Ascaphus truei* Stejneger. Copeia 1967:634–649.

NatureServe Explorer. 2002. An online encyclopaedia of life. Version 1.6. NatureServe. Arlington, VA. Available at http://www.natureserve.org/explorer/

Nielson, M., K. Lohman, and J. Sullivan. 2001. Phylogeography of the tailed frog (*Ascaphus truei*): Implications for the biogeography of the Pacific Northwest. Evolution 55(1):147–160.

Nishikawa, K.C. and D.C. Cannatella. 1991. Kinematics of prey capture in the tailed frog *Ascaphus truei* (Anura: Ascaphidae). Zool. J. Linn. Soc. 103:289–307.

Nishikawa, K.C. and G. Roth. 1991. The mechanisms of tongue protraction during prey capture in the frog *Discoglossus pictus*. J. Exp. Biol. 159:217–234.

Noble, G.K. and P.G. Putnam. 1931. Observations on the life history of *Ascaphus truei* Stejneger. Copeia 1931(3):97–101.

Nussbaum, R.A., E.D. Brodie, Jr., and R.M. Storm. 1983. Amphibians and reptiles of the Pacific Northwest. Univ. Idaho Press, Moscow, Idaho. 332 p.

Pauken, R.J. and D.E. Metter. 1971. Geographic representation of morphologic variation among populations of *Ascaphus truei* Stejneger. Syst. Zool. 20:434–441.

Reid, L.M. and T. Dunne. 1984. Sediment production from forest road surfaces. Water Resour. Res. 20(11):1753–1761.

Ritland, K., L.A. Dupuis, F.L. Bunnell, W.L.Y. Hung, and J.E. Carlson. 2000. Phylogeography of the tailed frog (*Ascaphus truei*) in British Columbia. Can. J. Zool. 78:1749–1758.

Smith, H.M. 1932. *Ascaphus truei* Stejneger in Montana. Copeia 1932:100.

Sutherland, G.D., L.A. Dupuis, and T. Wahbe. 2001. Status, distribution and ecology of the Olympic tailed frog (*Ascaphus truie*) and the Rocky Mountain tailed frog (*Ascaphus montanus*). A literature review. Landscape and Wildlife Advisory Group (LWAG) and Amphibian Res. Consortium (ARC). Wash. State Dep. Nat. Resour., Olympia, Wash.

Wahbe, T.R. 1996. Tailed frogs (*Ascaphus truei* Stejneger) in natural and managed coastal temperate rainforests of southwestern British Columbia, Canada. M.Sc. thesis. Univ. B.C., Vancouver, B.C. 49 p.

Wallace, R.L. and L.V. Diller. 1998. Length of larval cycle of *Ascaphus truei* in coastal streams of the Redwood Region, northern California. J. Herpetol. 32(3):404–409.

Welsh, H.H., Jr. 1993. A hierarchical analysis of the niche relationships of four amphibians from forested habitats of northwestern California. Ph.D. dissertation. Univ. Calif., Berkeley, Calif. 202 p.

Welsh, H.H., Jr. and A.J. Lind. 1991. The structure of the herpetofaunal assemblage in the Douglas-fir/hardwood forests of northwestern California and southwestern Oregon. *In* Wildlife and vegetation of unmanaged Douglas-fir forests. K.B. Aubry, A.B. Carey, and M.H. Huff (editors). U.S. Dep. Agric. For. Serv., Pac. Northwest Res. Stn., Portland, Oreg., Gen. Tech. Rep. PNW-285, pp. 394–413.

Welsh, H.H., Jr. and L.M. Ollivier. 1998. Stream amphibians as indicators of ecosystem stress: a case study from California's redwoods. Ecol. Appl. 8(4):1118–1132.

Wilkins, R.N. and N.P. Peterson. 2000. Factors related to amphibian occurrence and abundance in headwater streams draining second-growth Douglas-fir forests in southwestern Washington. For. Ecol. Manage. 139:79–91.

Wright, A.H. and A.A. Wright. 1949. Handbook of frogs and toads of the United States and Canada. Comstock Publishing Co., Inc., New York, N.Y.

Personal Communications

Antifeau, T. 2002. Min. Water, Land and Air Protection, Nelson, B.C.

Davidson, P. 2002. Min. Water, Land and Air Protection, Cranbrook, B.C.

TIGER SALAMANDER

Ambystoma tigrinum

Original prepared by Mike Sarell

Species Information

Taxonomy

The Tiger Salamander, *Ambystoma tigrinum,* belongs to the family Ambystomatidae (mole salamanders). Six subspecies are currently recognized (Green 1999), although as many as 10 have been proposed (Collins 1981). The taxonomy of Tiger Salamanders is uncertain and further taxonomic research may differentiate *A. tigrinum* into several different species. The "Blotched" Tiger Salamander (*A. tigrinum melanostictum)* occurs in British Columbia (Green 1999).

Description

Terrestrial adults are large (14–22 cm snout-vent-length [svl]) and robust with small eyes, a broad rounded snout, 13 costal groves, two tubercles on underside of feet, and no parotid glands. Colour pattern and markings are extremely variable but may be yellow or whitish mottling on a darker brown, grey, or black background. Larvae (8–38 mm svl) have large heads and gills that are longer than the length of the head (see Corkran and Thoms 1996). Fully aquatic adults (paedogens) can be extremely large with very robust gill apparatus. Only the Long-toed Salamander (*Ambystoma macrodactylum*) is sympatric with Tiger Salamanders in British Columbia and is easily differentiated by its much smaller size, a long third toe on the hind feet, and an irregular green-yellow stripe along the back, on a dark background.

Distribution

Global

The "Blotched" Tiger Salamander is widely but patchily distributed across southern Canada (Alberta, British Columbia, Saskatchewan) and the western United States (Washington, Oregon, Idaho, Montana, North and South Dakota, Wyoming, Nebraska, Colorado, Utah; Schock 2001).

British Columbia

In British Columbia, Tiger Salamanders occur in the southern Okanagan, north to Peachland; in the lower Similkameen, west to Keremeos; and in the Sidley and Kettle River valley, east to Christina Lake (Orchard 1991; Sarell and Robertson 1994; Sarell 1996; Sarell et al. 1998). This relatively small distribution in three drainages is weakly linked north of the international boundary, but is contiguous throughout its range to the south in Washington State (Leonard et al. 1993; Sarell 1996). Tiger Salamanders may occur in the southern part of the East Kootenay Trench. A disjunct population (possibly introduced) was found very close to the border in Eureka, Montana (J. Reichel, pers. comm.).

Forest region and districts

Southern Interior: Arrow Boundary, Okanagan Shuswap

Ecoprovinces and ecosections

SIM: SFH(?[1])
SOI: OKR, NOB, NOH, SOB, SOH, STU(?)

Biogeoclimatic units

BG: xh1
IDF: dk1, dk2(?), dm1, xh1
ICH: dw(?), mk1(?), mw2(?), xw
PP: dh1, dh2(?), xh1, xh1a

Broad ecosystem units

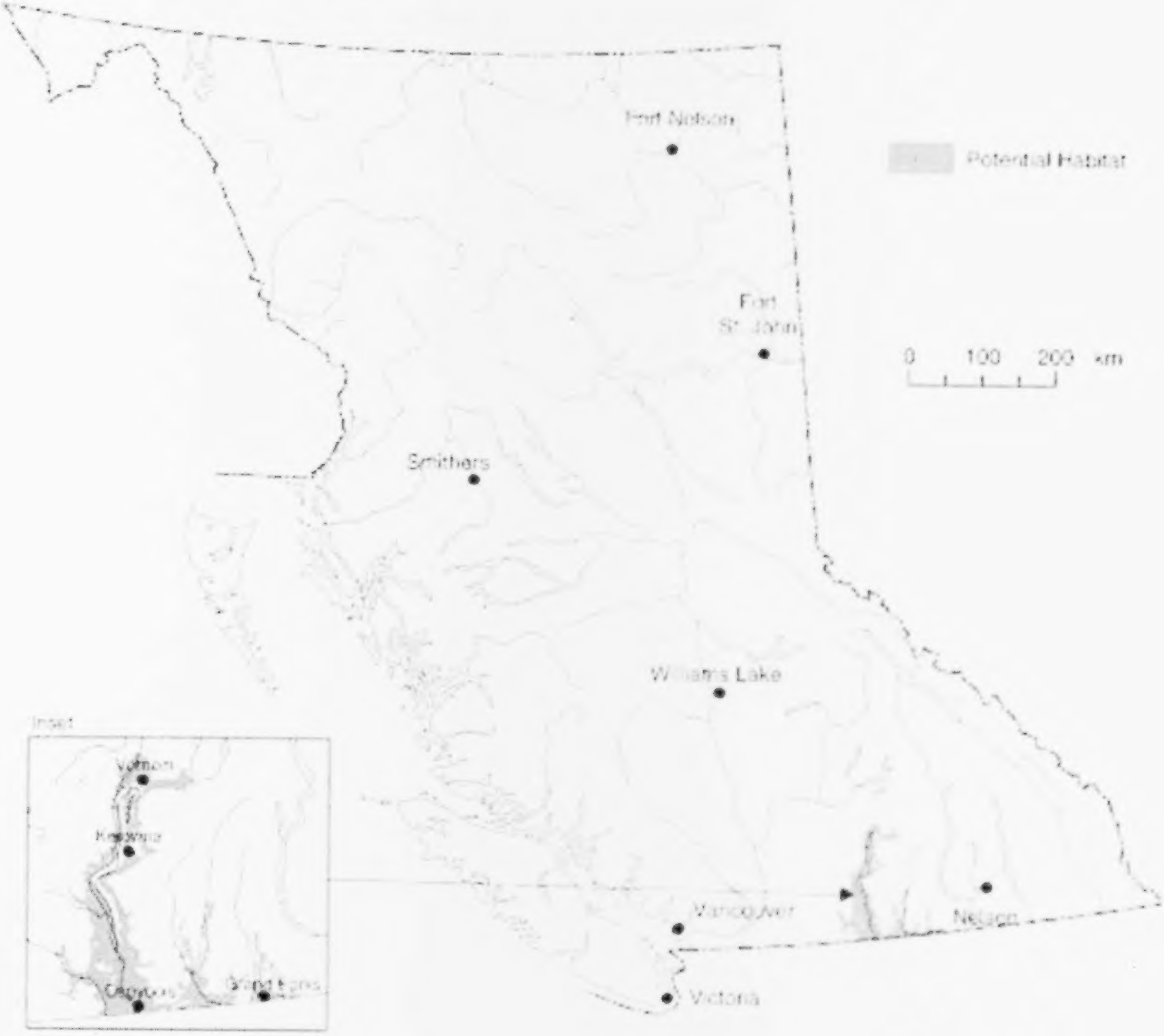
Terrestrial: AB, BS, CF, CR, DF, DP, OV, PP, RO, SS
Aquatic: LS

---

[1] (?) Indicates that the range extent has not been determined.

Tiger Salamander

(Ambystoma tigrinum)


Fort Nelson
Potential Habitat
Fort St. John
0 100 200 km
Smithers
Williams Lake
Inset
Vernon
Kelowna
Osoyoos
Grand Forks
Vancouver
Nelson
Victoria

Note: This map represents a broad view of the distribution of potential habitat used by this species. The map is based on several ecosystem classifications (Ecoregion, Biogeoclimatic and Broad Ecosystem Inventory) as well as current knowledge of the species' habitat preferences. This species may or may not occur in all areas indicated.

Elevation

Tiger Salamanders have been found from valley bottoms (300 m) up to 1250 m in British Columbia (Orchard 1991). Populations at higher elevations are usually found in areas with well-developed soils and a grasslands component.

Life History

Diet and foraging behaviour

Terrestrial adults are usually only seen travelling on land and at breeding ponds. Little is known of their terrestrial, subterranean, foraging behaviour. It is likely that much of the terrestrial foraging occurs in burrows, where arthropods and other invertebrates are encountered. Prey is known to consist of a large variety of invertebrates and occasionally small vertebrates. Aquatic forms (larvae, neotenes, and paedogens) prey on aquatic invertebrates and small vertebrates. A small percentage of terrestrial and aquatic morphs are cannibalistic, ensuring that under extreme conditions there will be sufficient food to perpetuate the species (Collins and Cheek 1983).

Reproduction

Reproduction occurs from March through August. Sexual maturity is generally reached in the first year, but can be delayed (neotony). In early spring, adult Tiger Salamanders congregate at aquatic breeding sites. Females deposit several hundred eggs, although more than 5000 can be produced by very large females in some subspecies (Bishop 1943; Rose and Armentout 1976). Eggs are deposited singly but they may be deposited over a small area. Females often attach eggs to submerged vegetation, rocks, or twigs in shallow water (<1 m deep). This usually occurs in April or May. Most terrestrial adults have left the breeding site by the end of May or June. Larvae hatch in 2–3 weeks and may metamorphose and leave the water at 3–4 months, usually during fall rains. Growth rates vary between ponds (Richardson et al. 2000a, 2000b). Neotony can occur under certain conditions, usually related to water chemistry (low iodine concentrations), food availability, and temperature. Paedogensis occurs when the larval form is retained and sexual maturity reached. This usually occurs in permanent water bodies, without fish. Paedogens have been documented at two sites in British Columbia and there is some evidence for the possibility of a third site (Sarell 1996).

Site fidelity

It is not known how philopatric individuals are to specific breeding sites but this species regularly breeds at several sites in the south Okanagan. Breeding site fidelity is unlikely if a breeding site is dry and another is detected or found. This tendency would follow that of the California Tiger Salamander (*Ambystoma californiense)* in which the majority of the population return to their natal pond but 20% were found to travel to new ponds (Trenham 1998).

Home range

Home range is not known but evidence suggests it is very limited (Richardson et al. 2000b). Richardson et al. (2000a) found that during the summer, Tiger Salamanders generally did not move far daily or even weekly, often remaining within a 5 m radius, but occasionally moving 10–100 m. The largest recorded movement was 250 m. This information was derived from individuals implanted with radio transmitters. Other observations of terrestrial adults have found them more than 1 km from possible breeding sites (Sarell 2000). The California Tiger Salamander has been found to usually return to their natal ponds; however, about 20% of the population venture to other ponds within 800 m (Trenham 1998). This information suggests a larger home range for at least some of the population.

Movements and dispersal

Movements and dispersal often coincide with specific environmental conditions, particularly temperature and rainfall (Loredo and Van Vuren 1996; Richardson et al. 2000b). Terrestrial adults migrate from terrestrial habitats to aquatic breeding sites in late winter or early spring (March and April). Richardson et al. (2000a) found that during the summer, Tiger Salamanders did not move >150 m from breeding locations in 1998 and not more than 500 m in 1999 (Richardson et al. 2000b). Semlitsch

(1998) found that adult salamanders from six species in the genus *Ambystoma* were found an average of 125.3 m from the edge of aquatic habitats. However, adult salamanders also have been found more than 1 km, and up steep slopes, from the nearest, potential breeding site (Sarell and Robertson 1994; Sarell 2000). Newly metamorphosed individuals emigrate from ponds to terrestrial habitats in August and early September, during heavy night rains.

Habitat

Structural stage

Tiger Salamanders likely prefer a structural stage of 2 (herb) and 3 (shrub/herb) but certainly use other structural stages where the forests are open and soils are suitable.

Important habitats and habitat features

Aquatic

The Tiger Salamander breeds in a variety of temporary and permanent aquatic habitats. In the south Okanagan many of these are small and frequently alkaline. Water depth, emergent vegetation, and an absence of predatory fish species are important characteristics of breeding sites (Orchard 1991). Tiger Salamanders typically lay their eggs in shallow, warm water that is <1 m deep. Emergent vegetation provides cover, a supply of invertebrates, and substrate for attaching eggs, but is not characteristic of all breeding sites.

Aquatic habitats that retain water until late July or August provide consistent breeding over those water bodies that dry prior to larvae metamorphosing. Neotenes (extended larval morphs) and paedogens (aquatic gilled adults) require permanent water bodies that do not freeze solid during the winter and preferably lack predatory fish. These water bodies provide nuclei for populations, especially during extended droughts.

Ephemeral water bodies (e.g., White Lake) provide extensive breeding opportunities during wet years, replenishing populations after dry years. Ephemeral ponds also permit range expansions during wet years. These small and shallow water bodies are especially important where deep lakes have been stocked with predatory fish.

Terrestrial

Important terrestrial habitats include riparian habitats adjacent to aquatic breeding sites, open sagebrush grasslands, and open forests. Tiger Salamanders spend most of their lives in underground refuges, such as small mammal burrows, particularly those of Great Basin Pocket Mouse (*Perognathus parvus*) and pocket gophers (*Thomomys talpoides*) (Vaughan 1961; Richardson et al. 2000b). The northern distribution of the Tiger Salamander in North America appears to be closely linked to the distribution of pocket gophers (Sarell 1996). Rodent burrows may be the limiting factor in terrestrial habitats as they provide abundant opportunities to gain subterranean access, have an abundance of prey, and provide adequate retreat depth for overwintering. Tiger Salamanders also retreat under coarse woody material or dig burrows (Semlitsch 1983). These retreats are used during the day or for short periods during the active season, and may be important during critical times, particularly juvenile dispersal (Richardson et al. 2000a).

Conservation and Management

Status

The Tiger Salamander is on the provincial *Red List* in British Columbia. In Canada, the southern mountain population is designated as *Endangered* (COSEWIC 2002).

Summary of ABI status in BC and adjacent jurisdictions (NatureServe Explorer 2002)

AB	BC	ID	MT	WA	Canada	Global
S4	S2	S5	S5	S3	N5	G5

Trends

Population trends

Population size and trend are not known. Populations may fluctuate significantly between years and annual recruitment is highly variable (Semlitsch 1983; Richardson et al. 2000b). In dry years, shallow ponds may dry up early and result in total reproductive failure. This has been observed at many sites in British Columbia (Orchard 1991; Sarell and Bryan 1993).

Anecdotal information strongly suggests that Tiger Salamanders in British Columbia are declining (Orchard 1991). Forty-one historic breeding sites were known in British Columbia of which about 16 still had successful breeding (Sarell 1996).

Habitat trends

In British Columbia, Tiger Salamanders occupy habitat that is greatly desired and impacted by people. The highest rate of habitat loss has been in the south Okanagan, primarily due to residential and agricultural developments. The expanse of roadways and increased traffic extend this influence into unsettled habitats. To a lesser extent, off-road traffic, invasive species, and concentrated livestock use appears to impair the suitability of relatively natural habitat (Orchard 1991; Sarell 1996; Schock 2001).

In the late 1980s it was calculated that about 10% of ecosystems in the south Okanagan remained relatively undisturbed (Redpath 1990). About half the riparian habitat in the south Okanagan Valley has been lost to urban or agricultural development over the last 50 years (Cannings et al. 1999). Human population growth, roads, and volume of traffic in the south Okanagan are expected to continue to increase.

Road-use statistics of Highway 97 in the south Okanagan record a range of 2872 to 20 017 vehicles per summer day (1–14 vehicles per minute) during the season when Tiger Salamanders are active (MOTH 1999). Despite lower traffic volumes at night, even the lowest level of two vehicles per minute provides very little chance of a Tiger Salamander successfully crossing the road.

Most known Tiger Salamander sites are on or surrounded by private land or rangeland. Some important habitats have been acquired by The Nature Trust of BC and BC Parks. Breeding habitats have been unintentionally created through the development of water impoundments and waste water lagoons.

Threats

Population threats

In British Columbia, populations in the valleys are extremely prone to heavy losses due to extensive land uses and high levels of traffic. It is quite possible that much of the Okanagan range will be lost and the remaining undeveloped and secured lands could be significantly impacted by road traffic. Lakes that support paedogenic populations continue to be managed for introduced fish. Paedogens maintain this species range during prolonged droughts.

Although Rainbow Trout (*Oncorhynchus mykiss*) are sympatric, most breeding sites are void of fish. Introduction of trout for sport fisheries is a major threat to Tiger Salamander populations in British Columbia. Predatory fish may compete for prey and feed on Tiger Salamander eggs and larvae (Orchard 1992). At least five major breeding populations in British Columbia have been lost or significantly impacted by fish stocking programs (Orchard 1991; Sarell 1996). This does not include the oxbows along the Okanagan River that are now teeming with non-native fish such as bass. Introduced fish can also carry and spread diseases that native amphibian species have little or no defence against.

Pesticides, fertilizers, and other contaminants are known to impact Tiger Salamanders (Power et al. 1989). Because they prey on a variety of invertebrates and vertebrates, Tiger Salamanders are sensitive to bioamplification (concentration of contaminants). Pesticides can result in direct and indirect effects that impact growth and development, reproduction, behaviour, as well as habitat and food quantity and quality (Bishop 1992). Even some inactive ingredients in pesticides, such as dispersants or wetting agents in herbicides, can impact gill respiration in tadpoles (Seburn and Seburn 2000).

Runoff from nitrate fertilizers can reduce the fitness of individuals by reducing activity and feeding, and increasing deformities in larvae of some amphibians (Seburn and Seburn 2000).

Infectious diseases have been found in Tiger Salamanders (Seburn and Seburn 2000; Davidson et al. 2000). Mass mortality at four lakes in Utah occurred from bacteria (Worthylake and Hovingh 1989). Chytrid fungus (genus *Batrachochytrium*) and *Ranavirus* have also been implicated in the declines or die-offs of Tiger Salamanders (Schock 2001). In British Columbia, a larval population experienced a die-off although it is not known what caused the event.

Habitat threats

The loss, alteration, and fragmentation of suitable habitat due to urban and agricultural development have been extensive in the south Okanagan. About half of the riparian habitat in the south Okanagan Valley has been lost to urban or agricultural development over the last 50 years (Cannings et al. 1999). Irrigation practices or water control systems, which lower water levels, can also impact Tiger Salamanders by stranding eggs, larvae, and neotenes. Irrigation developments also have enabled the conversion of terrestrial habitats into agricultural production.

Impacts from livestock grazing include soil compaction, trampling of wetland banks or edges and burrows, loss of riparian vegetation, and increased nutrient input to water (Orchard 1991; Richardson et al. 1998). If water quality is reduced at breeding sites due to livestock grazing, mass die-offs of Tiger Salamanders may occur due to increases in *Acinetobacter bacterium* (Worthylake and Hovingh 1989). Nutrient loading can also lead to dramatic increases of other pathogens or toxic levels of nitrites, especially during dry years (Worthylake and Hovingh 1989; Bishop 1992). Soil disturbances around the pond can also increase the rate of infilling and eventual loss of breeding habitat (Harvey et al. 2000). Heavy livestock use near the ponds can cause the collapse of small mammal burrow entrances, needed for aestivation (Harvey et al. 2000). Overall, the effects of livestock grazing are much less than many other anthropogenic effects, given the apparent reproductive and survival success in many areas that are grazed. The extent of the effects are probably linked to the intensity and timing of grazing. It is very unlikely that many Tiger Salamanders are trampled above ground, given that livestock do not travel much at night, when the salamanders are above ground.

Roads that intersect aquatic breeding and terrestrial habitats can result in increased road mortality during seasonal migrations. Richardson et al. (1998) reported up to 50 road mortalities on one day near one breeding site during September migrations. Mortalities from vehicle traffic may be one of the most significant effects, beside outright loss of habitats (Seburn and Seburn 2000). Prolonged and heavy all-terrain vehicle traffic may also significantly reduce habitat suitability.

Periodic drought is a natural limiting factor for Tiger Salamander populations (Orchard 1991). Annual and seasonal variations in precipitation and ground water flows may result in some ponds or wetlands drying up completely prior to metamorphosis of larvae. Human use of water for agricultural purposes may further reduce water levels and exacerbate these impacts.

The eggs of some amphibian species are vulnerable to increased UV radiation, resulting in reduced hatching success. Tiger Salamanders may be sensitive to the impacts caused by increased UV-B radiation (Seburn and Seburn 2000).

Legal Protection and Habitat Conservation

The Tiger Salamander is protected in that it cannot be killed, collected, or held in captivity without special permits, under the provincial *Wildlife Act*.

Tiger Salamanders require the protection of aquatic breeding habitat and nearby terrestrial habitats. Prior to the recent designation of some provincial parks, only 6% (4599 ha) of suitable Tiger Salamander habitat in the south Okanagan was currently designated as conservation lands (MELP 1998). Approximately 58% (42 241 ha) of suitable habitat is on Indian Reserves or private land and 36% (26 346 ha) was found on Crown land. Key areas that are afforded some protection are the White Lake Basin, South Okanagan Grassland Provincial Park, and the South Okanagan Wildlife Management Area.

Identified Wildlife Provisions

Sustainable resource management and planning recommendations

Maximize connectivity between known or suitable aquatic breeding sites, terrestrial foraging, and overwintering habitats by reducing agricultural and residential developments, as well as managing the impacts from traffic through these areas.

Wildlife habitat area

Goal

Maintain or recover the integrity of breeding and terrestrial habitats, ensuring the connectivity between these habitats is unimpeded.

Feature

Establish WHAs at breeding sites where breeding is known to occur.

Size

Most WHAs will be between 5 and 25 ha; however, the size of the WHA will ultimately depend on the size and number of wetlands included and area of suitable upland habitat.

Design

The WHA should include a core area and may include a management zone. The core area should include the aquatic breeding site(s) and suitable uplands within ~250 m to protect most of the aestivation habitat. A management zone may be included to capture high quality habitat or to provide connectivity between populations.

General wildlife measures

Goals

1. Minimize disturbance during the breeding season.
2. Minimize road mortality.
3. Maintain water quality.
4. Maintain water levels.
5. Minimize soil disturbance and trampling of burrows.
6. Maintain important habitat features (i.e., small mammal burrows, riparian and emergent vegetation, and non-compacted soils).
7. Maintain or remediate riparian and aquatic habitats to a properly functioning condition.

Measures

Access

- Do not construct roads, deactivate temporary road structures, and close roads during critical times, as recommended by MWLAP. Drift fences and culverts may be required by the statutory decision maker for locations where road mortality is extensive.

Harvesting and silviculture

- Do not harvest. When approved, selective harvesting methods are preferred.
- Minimize ground disturbances and do not scarify harvested areas.
- Do not place landings within core or management zone.
- Do not stock above natural densities so that open forest and grassland openings are maintained, as per a NTD4 fire maintained ecosystem.
- Salvage harvesting should follow the same guidelines as stated above.

Pesticides

- Do not use pesticides.

Range

- Plan livestock use in the core area to meet objectives described in general wildlife measures goals. Exclusion fencing may be required by the statutory decision maker to meet objectives.
- Do not place livestock attractants within WHA.

Additional Management Considerations

Minimize road traffic.

Prohibit fish stocking in WHAs or any fishless water body.

Ensure all-terrain vehicles do not have access to critical habitats and prevent incompatible recreation activities.

Ensure irrigation intake lines are screened.

Ensure breeding sites do not experience water extraction to the point that reproduction is impaired.

Maintain integrity of riparian areas of adjacent permanent and non-permanent wetlands.

Encourage private land stewardship where important habitats extend beyond Crown lands.

Information Needs

1. Determine the range and biogeoclimatic limits of the species.
2. Identify critical habitat feature requirements.
3. Determine the effects of contaminants and threats from infectious diseases.

Cross References

Badger, Burrowing Owl, Great Basin Spadefoot, Sandhill Crane

References Cited

Bishop, C.A. 1992. The effects of pesticides on amphibians and the implications for determining causes of declines in amphibian populations. *In* Declines in Canadian amphibian populations: designing a national monitoring strategy. C.A. Bishop and K.E. Pettit (editors). Can. Wildl. Serv., Environ. Can. Occas. Pap. No. 76., pp. 67–70.

Bishop, S.C. 1943. Handbook of salamanders. Comstock Publishing Company Inc., Ithaca, N.Y., pp. 159–174.

B.C. Ministry of Environment, Lands and Parks (MELP). 1998. Habitat atlas for wildlife at risk: South Okanagan and Lower Similkameen. Penticton, B.C.

B.C. Ministry of Transportation and Highways (MOTH). 1999. Traffic volumes: Thompson Okanagan Region. 1995–1999. Victoria, B.C.

Cannings, S.G., L.R. Ramsay, D.F. Fraser, and M.A. Fraker. 1999. Rare amphibians, reptiles, and mammals of British Columbia. B.C. Min. Environ., Lands and Parks, Wildl. Br. and Resour. Inv. Br., Victoria, B.C. 198 p.

Collins, J.P. 1981. Distribution, habitats and life history variation in the Tiger Salamander, *Ambystoma tigrinum*, in east-central and southeast Arizona. Copeia 1981(3):666–675.

Collins, J.P. and J.E. Cheek. 1983. Effects of food and density on development of typical and cannibalistic salamander larvae in *Amybstoma tigrinum nebulosum*. Am. Zool. 23:77–84.

Committee on the Status of Endangered Wildlife in Canada (COSEWIC). 2002. Canadian species at risk. Available from: www.speciesatrisk.gc.ca

Corkran, C.C. and C. Thoms. 1996. Amphibians of Oregon, Washington and British Columbia. Lone Pine Publishing, Vancouver, B.C.

Davidson, D, A.P. Pessier, J.E. Longcore, M. Parris, J. Jancovich, J. Brunner, D. Schock, and J.P. Collins. 2000. Chytridiomycosis in Arizona (USA) tiger salamanders. *In* Getting the Jump! on amphibian disease: Conf. and workshop compendium, Cairns, Australia, Aug. 26–30, 2000.

Green, D.M. 1999. The amphibians of British Columbia: A taxonomic catalogue. B.C. Min. Environ., Lands and Parks, Wildl. Br. and Resour. Inv. Br., Victoria, B.C. Wildl. Bull. No. B-87.

Harvey, D., J. Knight, and G. Cantebury. 2000. Proposed rule: California tiger salamander *Ambystoma californiense*. U.S. Fish and Wildl. Serv., Sacramento, Ca.

Leonard, W.P., H.A. Brown, L.L.C. Jones, K.R. McAllister, and R.M. Storm. 1993. Amphibians of Washington and Oregon. Seattle Audubon Soc., Seattle, Wash., pp. 18–21.

Loredo, I. and D. Van Vuren. 1996. Reproductive ecology of a population of the California tiger salamander. Copeia 4:895–901.

NatureServe Explorer. 2002. An online encyclopedia of life [Web application]. Version 1.6. Arlington, Va. Available from: http://www.natureserve.org/explorer.

Orchard, S.A. 1991. Provincial status report for the tiger salamander, *Ambystoma tigrinum*. Report prepared for B.C. Min. Environ., Wildl. Br., Victoria, B.C. 31 p. Unpubl.

______. 1992. Amphibian population declines in British Columbia. *In* Declines in Canadian amphibian populations: designing a national monitoring strategy. C.A. Bishop and K.E. Pettit (editors). Can. Wildl. Serv., Environ. Can., Occas. Pap. No. 76, pp. 10–13.

Power, T., K.L. Clark, A. Harfenist, and D.B. Peakall. 1989. A review and evaluation of the amphibian toxicological literature. Can. Wildl. Serv. Tech. Rep. 61.

Redpath, K. 1990. Identification of relatively undisturbed areas in the South Okanagan and Similkameen valleys, British Columbia. Can. Wildl. Serv., Pacific and Yukon Reg. Tech. Rep. Ser. No. 108. 9 p.

Richardson, J.S., W. Klenner, and J. Shatford. 1998. Tiger salamanders (*Ambystoma tigrinum*) in the south Okanagan: effects of cattle grazing, range condition and breeding pond characteristics on habitat use and population ecology. Habitat Conserv. Trust Fund, Victoria, B.C. Ann. Prog. Rep.

______. 2000a. The tiger salamander in British Columbia: An amphibian in an endangered desert environment. *In* Proc. Conf. on the Biology and Management of Species and Habitats at Risk, Kamloops, B.C., Feb. 15–19, 1999. L.M. Darling (editor). B.C. Min. Environ., Lands and Parks, Victoria, B.C., and Univ. Coll. Cariboo, Kamloops, B.C., pp. 407–412.

______. 2000b. Tiger salamanders (*Ambystoma tigrinum*) in the south Okanagan: effects of cattle grazing, range condition and breeding pond characteristics on habitat use and population ecology. Habitat Conserv. Trust Fund, Victoria, B.C. Ann. Prog. Rep.

Rose, L. and D. Armentrout. 1976. Adaptive strategies of *Ambystoma tigrinum* Green inhabiting the Llano Estacado of West Texas. J. Anim. Ecol. 45:713–729.

Sarell, M.J. 1996. Status of the tiger salamander (*Ambystoma tigrinum*) in British Columbia. B.C. Min. Environ., Lands and Parks, Wildl. Br., Oliver, B.C.

______. 2000. Wildlife and habitat mitigation activities for BC Gas' Southern Crossing Pipeline. Prepared for B.C. Gas, Vancouver, B.C. 12 p.

Sarell, M.J. and A.D. Bryan. 1993. Tiger salamander (*Ambystoma tigrinum*) management plan for British Columbia. South Okanagan Conservation Strategy, B.C. Habitat Conserv. Fund's Okanagan Endangered Spaces, and Okanagan Region Wildl. Heritage Fund Soc., Penticton, B.C.

Sarell, M.J., A. Haney, and S. Robertson. 1998. Inventory of Red- and Blue-listed wildlife within the southern Boundary Forest District. Prepared for B.C. Environ., Penticton, B.C. and Forest Renewal BC, Kamloops, B.C.

Sarell, M.J. and S. Robertson. 1994. Survey of Tiger Salamanders (*Ambystoma tigrinum*) in the Okanagan Sub-region (1994). B.C. Environ., Victoria, B.C. 5 p.

Schock, D.M. 2001. Status report on the tiger salamander, *Ambystoma tigrinum*, in Canada. Interim report prepared for the Committee on the Status of Endangered Wildlife in Canada.

Seburn, D. and C. Seburn. 2000. Conservation priorities for the amphibians and reptiles of Canada. Report prepared for World Wildl. Fund Canada and Can. Amphibian and Reptiles Conserv. Network. 92 p.

Semlitsch, R.D. 1983. Burrowing ability and behavior of salamanders of the genus *Ambystoma*. Can. J. Zool. 61:616–620.

______. 1998. Biological delineation of terrestrial buffer zones for pond-breeding amphibians. Conserv. Biol. 12(5):1113–1119.

Trenham, P. 1998. Demography, migration, and metapopulation structure of pond breeding salamanders. Ph.D. dissertation. Univ. Calif., Davis, Calif. 98 p.

Vaughan, T.A. 1961. Vertebrates inhabiting pocket gopher burrows in Colorado. J. Mammal. 42(2):171–174.

Worthylake, K.M. and P. Hovingh. 1989. Mass mortality of salamanders (A*mbystoma tigrinum*) by bacteria (Acinetobacter) in an oligotrophic seepage mountain lake. Great Basin Nat. 49:364–372.

Personal Communication

Reichel, J. 2002. Montana State Dep. Wildl., Helena, Mont.

"GREAT BASIN" GOPHER SNAKE

Pituophis catenifer deserticola

Original[1] prepared by Nadine Bertram

Species Information

Taxonomy

The Gopher Snake *(Pituophis catenifer)* is a member of the family Colubridae that includes the majority of the world's non-venomous snake species. Six subspecies of *P. catenifer* are currently recognized, two of which have been documented in British Columbia: *P. catenifer catenifer* and *P. catenifer deserticola* (Gregory and Gregory 1999). *P. catenifer deserticola*, hereafter referred to as the Great Basin Gopher Snake, is confined to the Southern Interior of British Columbia, while *P. catenifer catenifer* is suspected to be extirpated from British Columbia (Cannings et al. 1999).

Description

Adults are generally between 70 and 200 cm, but may exceed 240 cm (Gregory and Campbell 1984; Shewchuk 1996). They are usually very light brown or yellowish-brown with superimposed dark brown-black squares running from the head to the tail; on the tail the squares become more like stripes or cross-bands (Gregory and Campbell 1984). Smaller, more irregularly shaped dark brown-black markings occur along the sides of the body and the ventral surface is a creamy yellowish colour (Gregory and Campbell 1984). Scutes on the snakes back are lightly keeled, while all other body scutes are smooth; two rows of subcaudal scutes are present (Gregory and Campbell 1984).

The head is slightly wider than the neck; the eyes are relatively large with a round pupil (Gregory and Campbell 1984). Three distinctive markings (dark brown-black) occur on the head, including a horizontal band between the eyes, a vertical line running from below the eye to the upper jaw, and an angled stripe running from the eye to the angle of the jaw (Gregory and Campbell 1984).

Distribution

Global

The Great Basin Gopher Snake occurs in southern British Columbia and the western United States including Washington, Oregon, Colorado, Nevada, Wyoming, Arizona, and New Mexico.

British Columbia

The Great Basin Gopher Snake has a patchy distribution throughout the warm, dry grassland valleys of the interior with the highest population densities occurring in low elevation areas of the Thompson and Okanagan valleys. Gopher snakes also occur in the Fraser Valley (from at least as far south as Lytton north to Churn Creek) and the Nicola and Similkameen valleys (Hobbs and Sarrel 2000), and have also been found in the Kettle Valley, from Rock Creek east to Christina Lake (Hobbs and Sarell 2000).

Forest region and districts

Southern Interior: 100 Mile House, Arrow Boundary, Cascades, Central Cariboo, Kamloops, Okanagan Shuswap (Salmon Arm)

Ecoprovinces and ecosections

CEI: FRB

SOI: NOB, NOH, OKR, PAR, SHB, SOB, SOH, STU, THB, TRU

Biogeoclimatic units

BG: xh, xw

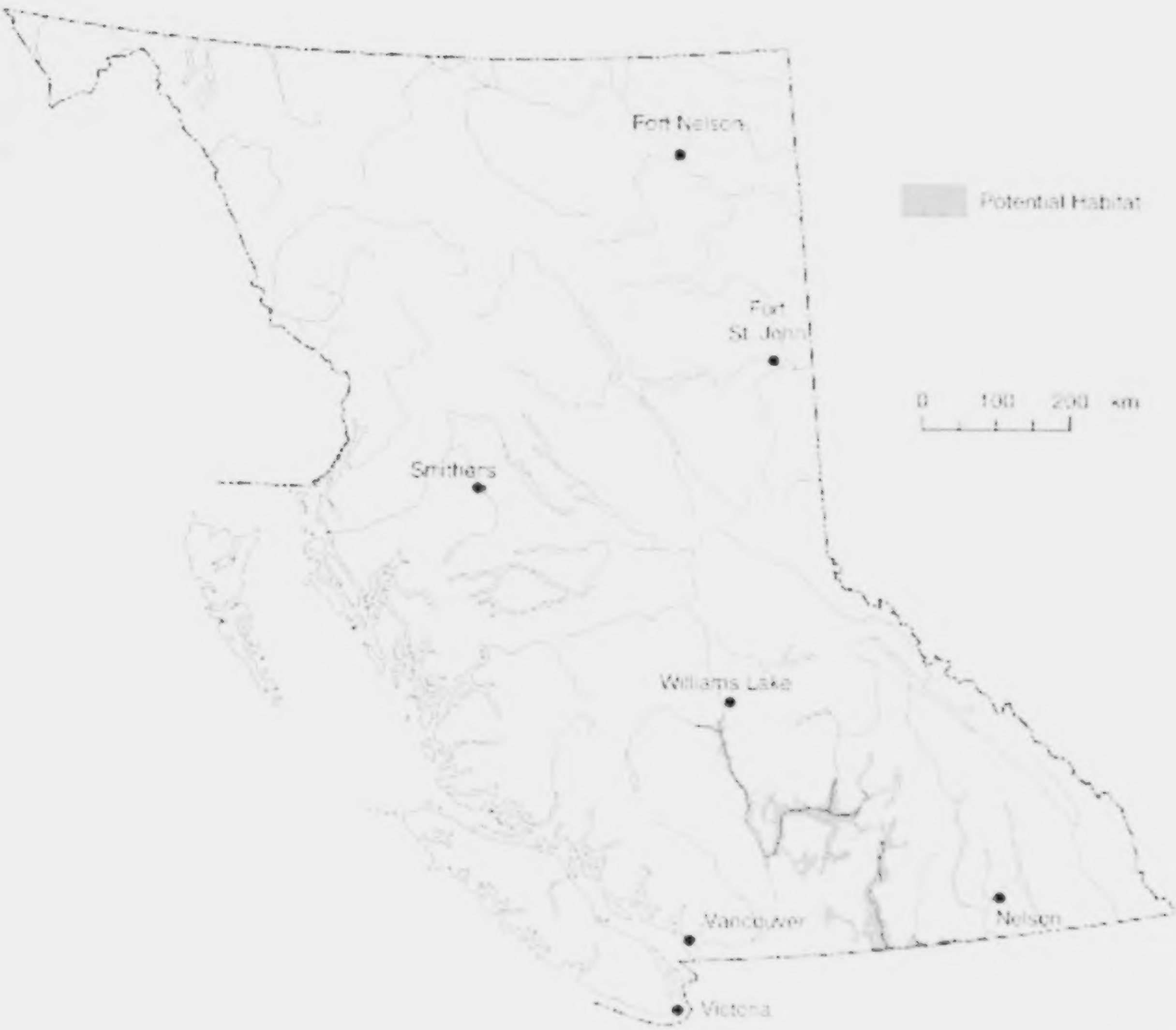
IDF: xh (including a and b phases), xm, xw

PP: dh1, dh2, xh1

---

[1] Volume 1 account prepared by C. Shewchuk.

Gopher Snake - subspecies *deserticola*
(*Pituophis catenifer deserticola*)


Fort Nelson
Potential Habitat
Fort St. John
0 100 200 km
Smithers
Williams Lake
Vancouver
Nelson
Victoria

Note: This map represents a broad view of the distribution of potential habitat used by this species. The map is based on several ecosystem classifications (Ecoregion, Biogeoclimatic and Broad Ecosystem Inventory) as well as current knowledge of the species' habitat preferences. This species may or may not occur in all areas indicated.

Broad ecosystem units

AB, BS, CR, DP, OV, PP, SS, UR

Elevation

250–1100 m

Life History

Diet and foraging behaviour

The Great Basin Gopher Snake uses constriction to kill its prey before ingesting it. Shewchuk (1996) found that in the south Okanagan, small rodents, such as voles, pocket mice, and deer mice, comprised 91% of the gopher snakes diet and juvenile birds accounted for the remaining 9%. Shewchuk (1996) found a high abundance of neonate rodents and juvenile swallows (*Hirundo* spp.) in the diet, indicating that gopher snakes actively forage by searching rodent burrows and by climbing to reach bird nests. Seigel and Collins (1993) found that as air and ground temperatures increase from 18 to 27°C, the activity, movements, and prey capture success of the gopher snake also increased.

Reproduction

Mating occurs in May. Typically ovulation follows in early June and the eggs are deposited between late June and early July (Parker and Brown 1980; Shewchuk 1996). In the south Okanagan, Shewchuk (1996) reported that gravid females ($n = 19$) deposited between two and eight eggs each (mean, 4.6) and clutch size was significantly correlated to female snout-vent-length. Egg-laying sites are known to occur in abandoned rodent burrows in sandy substrates, commonly in flat areas or on south-facing slopes; talus slopes in rocky habitats also may be used (Parker and Brown 1980; Shewchuk 1996). Nest sites often are communal, containing the eggs of several females, and often include the eggs of other species such as the Racer *(Coluber constrictor mormon)* (Parker and Brown 1980; Shewchuk 1996). Incubation occurred for ~60–80 days and hatchlings emerged in late August or early September (Shewchuk 1996).

Site fidelity

Successive use and fidelity to hibernacula, egg-laying sites, and foraging areas has been documented in Utah and the south Okanagan (Parker and Brown 1980; Shewchuk 1996). In addition, Shewchuk (1996) observed the repeated use of "retreat sites" (locations that provide shelter and thermal protection) in the south Okanagan. Retreat sites were used repeatedly by individuals to provide cover when the snakes were not actively foraging. Several gopher snakes were observed returning to these areas within and across active seasons.

Home range

Gopher snakes studied in the south Okanagan were found to have relatively large mean home ranges (13.9 ha females, 5.3 ha males) compared with those studied in Utah (1–3 ha), possibly due to a different distribution of food resources and critical habitats (Shewchuk 1996). In the Thompson, the approximate summer home range sizes of two male gopher snakes were 5 ha and 18 ha, respectively, and one gravid female used a home range of ~25 ha (Bertram and Larsen 2001). One possible explanation for the large size of female home ranges in the south Okanagan (and Thompson) may be large movements to suitable egg-laying sites that may be located some distance from the snakes primary foraging habitat (Shewchuk 1996).

Movements and dispersal

In British Columbia, this species hibernates in dens for a large part of the year (November to March). The over wintering sites are often communal, and typically shelter more than one snake species (i.e., *Crotalus oreganus, Coluber constrictor, Hypsiglena torquata, Thamnophis elegans*). Depending on weather, the snakes emerge from hibernation in late March or early April. Shortly after emergence from hibernation the snakes disperse to summer foraging and egg-laying habitats. In the south Okanangan, Shewchuk (1996) found a mean dispersal/return distance of 934 m. A study in the Kamloops area found return distances of between 275 and 520 m (Bertram and Larsen 2001).

The majority of movements during the summer feeding period are usually <200 m; between feedings or during ecdysis (shedding), the Great Basin Gopher Snake may be inactive for 10–15 days (Parker and Brown 1980; Shewchuk 1996; Bertram and Larsen 2001). Gravid females may travel substantial distances to locate suitable egg-laying sites. Migrations of 440 m and 2188 m have been observed (Shewchuk 1996; Bertram and Larsen 2001). Movements during the spring and fall usually are diurnal while during the summer the snakes may become nocturnal to avoid the heat (Greene 1997).

Habitat

Structural stage

1: non-vegetated/sparse
2: herb
3: shrub/herb

Important habitats and habitat features

Denning

Most known den sites are located within rock outcrops or talus habitat. These sites provide specific thermal and moisture regimes that protect snakes from freezing and dehydration. Most den sites are located on south-facing slopes in the Ponderosa Pine or Bunchgrass biogeoclimatic zones (Hobbs and Sarell 2000; Bertram and Larsen 2001). Hibernacula have been found in various areas, for example within a talus slope below a cliff, and in horizontal rock cracks at the base of cliffs (Shewchuk 1996). In general, dens have been located at elevations of ~450 m (Shewchuk 1996; Bertram and Larsen 2001). In some cases gopher snakes may hibernate alone or with a relatively small number of snakes in rodent burrows or other inconspicuous openings. Two gopher snakes in the Thompson area were observed overwintering in areas such as these. One is a rodent hole complex on the southeast facing slope of a small gully in open grassland habitat (elevation 400 m); the second is an opening produced by a dead and decaying sagebrush in the coarse gravel of a railway bed (elevation 350 m) (Bertram and Larsen 2001).

Breeding

Egg-laying sites also tend to be on south-facing slopes, but are more likely to be found in abandoned rodent burrows than in talus or rock outcrops. Several egg-laying sites in the south Okanagan and one in the Thompson have been found near the crest of large sand banks (Shewchuk 1996; Bertram and Larsen 2001). These sites contained minimal vegetation with loose, sandy soils, probably enabling partial excavation by the snakes. The sites also appeared to be well drained and were south to southeast facing. Studies indicate that egg-laying sites may be selected based on specific thermoregulatory criteria to ensure optimum conditions for development of the embryos (Shewchuk 1996).

Foraging

Gopher snakes tend to forage in open grassland habitats but riparian areas within the grassland habitat may also be important. Shewchuk (1996) found that after dispersal, individual gopher snakes spent most of their time moving in the riparian habitats of the south Okanagan study area; two of three gopher snakes followed in the Thompson had a riparian component within their home range (Bertram and Larsen 2001). The third gopher snake foraged in an open grassland habitat that included two dry gullies but no riparian areas, several other gopher snakes were observed in this area throughout the summer (Bertram and Larsen 2001). In the Kamloops area, rodent holes and to a lesser extent, rock outcroppings and wildlife trees (class 8 and 9 [dead fallen]) were observed to be important sources of cover for the snakes (Bertram and Larsen 2001). These sites offer physical cover and thermal protection for the snakes between foraging movements (Shewchuk 1996).

Conservation and Management

Status

The Great Basin Gopher Snake is on the provincial *Blue List* in British Columbia. Its status in Canada has not been determined (COSEWIC 2002).

Summary of ABI status in BC and adjacent jurisdictions (NatureServe Explorer 2002)

AB	BC	ID	MT	OR	WA	Canada	Global
S3*[a]	S3	S5*	S5*	S5*	S5*	N3	G5T5

[a] NatureServe has not yet assessed the status of this subspecies; thus, these ranks reflect the status at the species level and are not specific to the *deserticola* subspecies.

Trends

Population trends

Estimates of abundance in British Columbia are not available. This snake is known to occur at many locations within the Thompson, Okanagan, Similkameen, and Fraser valleys, but critical habitats such as communal hibernacula have not been identified in most cases; therefore population monitoring is very difficult. Although population data are not available, significant development has occurred and continues to occur in areas known to support gopher snakes (see below); population declines due to habitat loss in the past, present, and future are therefore highly probable.

Habitat trends

Since settlement of the southern interior began, significant alteration of snake habitat has occurred. Most human developments, such as residential, industrial, and agricultural, occur within the valley bottoms. As human populations increase, development also is accelerating; this trend is evident throughout the range of the Great Basin Gopher Snake, particularly in the south Okanagan and Similkameen (SOS 2000).

Threats

Population threats

The Great Basin Gopher Snake has a restricted range in the province. Its populations are also seasonally concentrated at den sites, causing this species to be susceptible to disturbance and local extirpation. Specific microclimatic conditions make these sites unique and they are limited within the habitat (Shewchuk 1996). Entire snake populations may be destroyed if these sites are lost or altered as a result of human activities or natural occurrences.

Roads and railways that bisect the summer range of this snake represent a significant source of mortality, as gopher snakes often are killed or injured while migrating across or basking in these locations (Shewchuk 1996; Bertram and Larsen 2001). Mortality caused by agricultural activities such as cattle grazing and crop harvesting also is evident in the south Okanagan and Thompson areas (Shewchuk 1996; Bertram and Larsen 2001). In addition, the superficial resemblance of this non-venomous snake to the venomous Western Rattlesnake *(Crotalus oreganus)* results in unfounded persecution (Bertram and Larsen 2001).

Habitat threats

In British Columbia, the main threat to this species is habitat loss and alteration due to urban and agricultural development and livestock grazing. Grazing is likely to increase exposure to predators by causing a reduction of available ground cover within critical summer habitats (Hobbs and Sarell 2000; G. Schuett, pers. comm.). Human developments in the grassland/shrub-steppe habitat are expanding, resulting in population declines and loss of species, particularly vertebrates (SOS 2000).

Road development also contributes to habitat fragmentation and loss (Shewchuk 1996; Bertram and Larsen 2001). Recreational activities such as all-terrain vehicle use currently pose a minor threat to habitat through compaction and degradation of soils and vegetation.

Legal Protection and Habitat Conservation

The Great Basin Gopher Snake is protected in that it cannot be killed, collected, or held in captivity without special permits, under the provincial *Wildlife Act*.

Several ecological reserves (i.e., Tranquille, Haynes Basin) and provincial parks (i.e., Lac du Bois, Kalamalka Lake) contain suitable gopher snake habitat. At least seven known hibernacula are within protected areas including Okanagan Mountain and Kalamalka provincial parks; Trout Creek and Thorne ecological reserves; and White Lake, Churn Creek, and South Okanagan Grasslands protected areas.

Under the results based code, range use plans that consider the requirements of this species may be sufficient to meet the needs of the species. However, for a species to be specifically addressed within these plans, they must be designated as Identified Wildlife. Wildlife habitat features may be used to protect den sites.

Identified Wildlife Provisions

Sustainable resource management and planning recommendations

❖ Maintain and maximize connectivity between hibernacula and foraging habitats.

Wildlife habitat area

Goal

Maintain and link denning and foraging habitat, travel corridors, and egg-laying sites within and between adjacent populations.

Feature

Establish WHAs at communal dens, especially for multi-species dens, and talus slopes, rock outcrops or cliff habitats identified to be important for the conservation of this species.

Size

Approximately 200–300 ha but will depend on site-specific factors such as area of suitable habitat, nearness to foraging areas, and egg-laying sites.

Design

The boundaries of the WHA should be designed to include and connect den sites, travel corridors, egg-laying sites, and important foraging areas.

General wildlife measures

Goals

1. Minimize disturbance and mortality, particularly road mortality.
2. Maintain critical structural elements such as rock outcrops, talus slopes, friable soils, coarse woody debris, friable soils, rodent burrows, concentrations of boulders, or other unconsolidated materials and vegetative cover.
3. Maintain microclimatic conditions of hibernacula.
4. Maintain moderate to dense cover to conceal snakes and maintain foraging opportunities.
5. Maintain WHA in a properly functioning condition.

Measures

Access

- Place roads as far as practicable from hibernacula and known snake travel corridors. Avoid construction between April and October when snakes are active. When recommended by MWLAP, rehabilitate temporary access roads immediately after use or gate less temporary roads to reduce traffic.
- Where determined to be necessary by MWLAP, use snake drift fences and drainage culverts at intersections of roads and known travel corridors. Drift fences should be ≥75 cm high. Length will vary by site depending on area used by snakes. Consult MWLAP for more information. Seasonal use restrictions may be appropriate for some roads. Do not remove or disturb rock or talus.

Harvesting and silviculture

- Do not harvest within 200 m of den sites. Retain coarse woody debris.

Pesticides

- Do not use pesticides.

Range

- Plan livestock grazing (e.g., timing, distribution, and level of use) to prevent trampling and maintain suitable vegetative cover (i.e., >15 cm height in upland areas; >10 cm height in riparian areas).
- Do not concentrate livestock within 200 m of den site during spring dispersal (March/April) and fall (September/October) aggregations.
- Do not place livestock attractants or corrals within 200 m of den site.
- Do not trail livestock within 200 m of den site during spring and fall aggregations.
- When hay cutting or prescribed burning is planned, consult with MWLAP for the preferable times (i.e., after snakes have returned to dens).

Recreation

- Do not establish recreation sites within WHA.

Additional Management Considerations

Where migration routes from denning locations to summer habitats have been transected by roads, use methods such as drift fences, culverts, or seasonal road restrictions to allow the safe passage of snakes.

Rock climbing should be considered a disturbance at sensitive sites.

Riparian areas adjacent to WHA should be managed or restored to ensure foraging habitat is maintained.

Avoid converting areas adjacent to WHA to an early seral grassland condition. Early seral stages may have less cover for concealing snakes from predators and they may experience greater threats from trampling due to higher livestock pressures.

Information Needs

1. Inventory of hibernacula, egg-laying sites, and foraging areas.
2. Monitoring of hibernacula to provide population data.
3. Increased knowledge of life history, specifically reproduction.

Cross References

Badger, Racer, Western Rattlesnake

References Cited

Bertram, N.A. and K.W. Larsen. 2001. Identification of critical habitats for the Western Rattlesnake and Great Basin Gopher Snake in the Thompson-Nicola region of BC. Report prepared for the Habitat Conserv. Trust Fund. Unpubl.

Cannings, S.G., L.R. Ramsay, D.F. Fraser, and M.A. Fraker. 1999. Rare amphibians, reptiles and mammals of British Columbia. B.C. Min. Environ., Lands and Parks, Wildl. Br. and Resour. Inv. Br., Victoria, B.C. 190 p.

Committee on the Status of Endangered Wildlife in Canada (COSEWIC). 2002. Canadian species at risk. Available from: http://www.speciesatrisk.gc.ca

Greene, H.W. 1997. Snakes: the evolution of mystery in nature. Univ. Calif. Press, Berkeley and Los Angeles, Calif.

Gregory, P.T. and R.W. Campbell. 1984. The reptiles of British Columbia. B.C. Provincial Mus., Victoria B.C.

Gregory, P.T. and L.A. Gregory. 1999. The reptiles of British Columbia: A taxonomic catalogue. B.C. Min. Environ., Lands and Parks, Victoria, B.C. Wildl. Bull. No. B-88.

Hobbs, J. and M. Sarell. 2000. Gopher snakes (and cohorts): An assessment of selected den sites in the South Okanagan. Report prepared for B.C. Min. Environ., Lands and Parks, Victoria, B.C. Unpubl.

NatureServe Explorer. 2002. An online encyclopedia of life [Web application]. Version 1.6. Arlington, Va. Available from: http://www.natureserve.org/explorer

Parker, W.S. and W.S. Brown. 1980. Comparative ecology of two colubrid snakes in northern Utah. Milwaukee Public Mus., Milwaukee, Wis. Publ. Biol. Geol. No. 7.

Seigel, R.A. and J.T. Collins. 1993. Snakes: ecology and behaviour. McGraw-Hill Co., New York, N.Y. 414 p.

Shewchuk, C.H. 1996. The natural history and movement patterns in the Gopher Snake (*Pituophis melanoleucus*) in southern British Columbia. M.Sc. thesis. Univ. Victoria, Victoria, B.C.

South Okanagan-Similkameen Conservation Program (SOS). 2000. A prospectus. Environment Canada. 16 p. Available from: http://www.soscp.org/docs/soscp.pdf

Personal Communication

Schuett, G. 2002. Univ. Arizona, Phoenix, Ariz.

ANCIENT MURRELET

Synthliboramphus antiquus

Original[1] prepared by Anne Harfenist

Species Information

Taxonomy

The Ancient Murrelet belongs to the family Alcidae, the auks. It is the only one of four species in the genus *Synthliboramphus* to occur commonly and regularly in British Columbia (Gaston 1994a). Within the alcids, the Ancient Murrelet is most closely related to the Japanese Murrelet (*Synthliboramphus wumizusume*) found only near Japan; the other two *Synthliboramphus* murrelets are Craveri's (*S. craveri*) and Xantus' (*S. hypoleucus*) murrelets, which are found primarily near the Gulf of California and along the coast of California to Baja California, respectively (Gaston and Jones 1998). Two races of Ancient Murrelet have been described: *Synthliboramphus antiquus antiquus* and *S. antiquus microrhynchos* but Gaston and Jones (1998) call the validity of the latter race, found only on the Commander Islands, doubtful.

Description

The Ancient Murrelet is a relatively small auk with a wing length of ~14 cm and weighing about 200–250 g (Gaston 1994a). Males and females are similar in appearance: in adults the back, upper wings, and upper tail are moderate grey; the head is black; the belly is white; legs and feet are pale blue; and the short pointed bill is pinkish. In breeding plumage, Ancient Murrelets have a black bib that extends from the throat down to the upper breast and long white filamentous plumes along the sides of the crown which are the feature that give the bird the "ancient" look for which they are named (Gaston 1994a). The non-breeding plumage lacks the black bib and the plumes are reduced; this plumage is not maintained for very long and many birds seen in December are in breeding plumage (Gaston and Jones 1998). The plumage of immature Ancient Murrelets is similar to that of the winter adult with no plumes and a white throat (Gaston 1994a). Chicks are covered with down in a colour pattern similar to that of immature birds.

Distribution

The Ancient Murrelet spends most of its life at sea, coming to land only to breed.

Global

The range of the Ancient Murrelet describes an arc around the rim of the northern Pacific Ocean. Breeding colonies are found on offshore islands north from China in the western Pacific (35–62° N), across the Aleutian Islands and south through the Queen Charlotte Islands/Haida Gwaii in the eastern Pacific (52–60° N) (Gaston and Jones 1998). The at-sea distribution of the birds during the breeding season covers approximately the same geographic range. The wintering distribution includes the waters used during the breeding season, but extends into the Bering Sea in the north and along the eastern Pacific coast south to Baja California (Gaston and Jones 1998). In the eastern Pacific Ocean, Ancient Murrelets are probably most numerous in winter between 40 and 50° N (Gaston 1994a). The distribution of this species during the post-breeding season until the birds reach the wintering grounds is unknown.

British Columbia

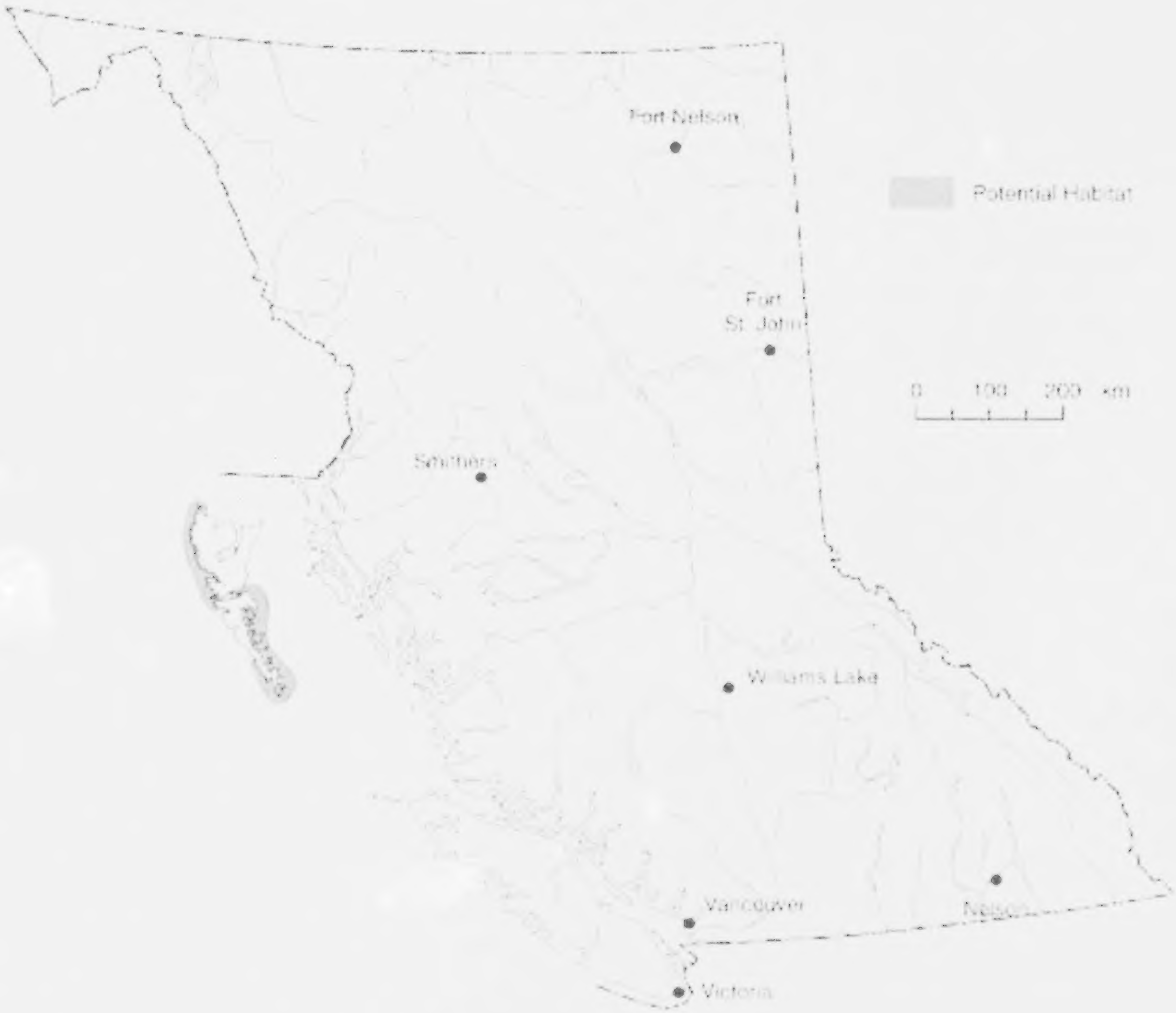
Known Ancient Murrelet breeding colonies in British Columbia are confined to offshore islands in the Queen Charlotte Islands/Haida Gwaii (Rodway 1991). Approximately one-half of the birds nest at three large colonies off the northwest side of

---

[1] Volume 1 account prepared by A. Derocher.

Ancient Murrelet

(Synthliboramphus antiquus)


Fort Nelson
Potential Habitat
Fort St. John
0 100 200 km
Smithers
Williams Lake
Vancouver
Nelson
Victoria

Note: This map represents a broad view of the distribution of potential habitat used by this species. The map is based on current knowledge of the species' habitat preferences. This species may or may not occur in all areas indicated.

Graham Island and about 44% breed at 17 colonies off the east coast of Moresby Island; the remaining 7% nest at 10 small colonies off the northwest side of Moresby Island (Rodway et al. 1988, 1990, 1994). A single incubating adult was reported from the Moore Islands along the mainland coast in 1970 (Campbell et al. 1990), but a subsequent survey in 1988 did not find evidence of breeding at that site (Rodway and Lemon 1991). The presence of Ancient Murrelets in breeding plumage on the waters off northwestern Vancouver Island during the breeding season may indicate a small colony/colonies in that area but nesting has not been confirmed (Gaston 1994b). Birds are common and abundant on the waters near their colonies during the breeding season.

Ancient Murrelets are rarely seen in British Columbia waters during late summer and early fall (Campbell et al. 1990). Wintering aggregations occur in the marine waters around Vancouver Island including Queen Charlotte Strait, Strait of Juan de Fuca, Haro Strait, and Active Pass (Campbell et al. 1990). Smaller numbers of Ancient Murrelets winter throughout coastal British Columbia, but the birds are rarely found in protected inland waters such as fjords and inlets.

Forest region and district[2]

Coast: Queen Charlotte Islands

Ecoprovinces and ecosections

Nesting:

COM: SKP, WQC

At-sea:

COM: DIE, HES, QCS, QCT, VIS

GED: JDF, SOG

NOP: JOS, NCF, OQC, QCC, SAP, TPR, VIC

Biogeoclimatic units (nesting)

CWH: vh2, wh1

Broad ecosystem units

CH, HS

Life History

Diet and foraging behaviour

Few data are available on the diet of the Ancient Murrelet. The diet appears to consist primarily of large zooplankton and small schooling fish; specific prey species and relative proportions in the diet vary across the range of the murrelet (e.g., Gaston 1994a) and among years (Sealy 1975; Vermeer et al. 1985). In one study conducted near Langara Island, the diet of adults was comprised primarily of euphausiids early in the breeding season: *Euphausia pacifica* in late March/early April and *Thysanoessa spinifera* in late April/May (Sealy 1975). In June, approximately half of the diet was juvenile sand lance (*Ammodytes hexapterus)* with euphausiids making up the other half. Juvenile shiner perch (*Cymatogaster aggregata)* and rockfishes (*Sebastes* spp.) were also consumed later in the breeding season (Sealy 1975). The diet of subadults was dominated by euphausiids (primarily *Thysanoessa spinifera)* and sand lance. Another study in the same area but in a different year found significant amounts of fishes in the diet of adults in May; in June the diet was almost exclusively larval and juvenile fish including ~25% rockfish as well as greenlings (*Hexagrammas* spp.) and flatfish (Pleuronectidae) (Vermeer et al. 1985). Young-of-the-year, presumably shortly after independence from their parents, forage almost entirely on sand lance (Sealy 1975; Gaston 1992).

The only information on the winter diet of Ancient Murrelets comes from birds off southeastern Vancouver Island (Gaston et al. 1993). Almost the entire diet was comprised of *Euphausia pacifica* throughout the winter except in November when significant amounts of juvenile herring (*Clupea harengus)* were eaten.

Ancient Murrelets forage in marine waters. They tend to forage over the continental shelf and slope; in British Columbia they forage most commonly over the shelf break and in areas where tidal upwellings force food close to the surface (Vermeer et al. 1985; Gaston 1994a). The main method of prey capture is pursuit diving to depths of 10–20 m; the birds use their wings to propel themselves under water (Gaston 1992). On occasion, murrelets also feed at the surface (Gaston 1992). Ancient Murrelets usually forage in small groups and are found in either single species or mixed species feeding flocks (Gaston 1992; Gaston et al. 1993). Chicks are fed by their parents for more than a month after leaving the nesting colony (Litvinenko and Shibaev 1987).

---

[2] Only forest districts with breeding habitats are listed.

Reproduction

The timing of breeding in Ancient Murrelets varies across the species' range: there is a 6-day delay for every 1° C decrease in mean April sea surface temperature near the colonies (Gaston 1992). Timing is not related to latitude, which suggests that food supply rather than day length is a critical factor (Gaston 1994a). The information presented below is for the Queen Charlotte Islands/Haida Gwaii, the only breeding area in British Columbia.

Ancient Murrelets are colonial burrow-nesters. The birds begin to visit their colonies in March and begin laying eggs 1–10 April (Gaston and Jones 1998). During the pre-laying period, the birds are seen in late afternoon on the waters around the nesting colonies and on land at night (Gaston 1992). Egg-laying at a colony occurs over about 45 days, but approximately one-half of all clutches are initiated within a single 6–10 day period (Gaston and Jones 1998). Dates of median clutch completion are 17 April–9 May (Gaston and Jones 1998). Almost all clutches consist of 2 eggs laid 6–10 days apart (Gaston 1994a). Adults begin incubation 1–2 days after the second egg is laid; the eggs may be neglected up to 7 days before incubation begins (Gaston 1994a). Only one clutch is produced per year.

Incubation lasts for approximately 1 month and is shared equally between parents, with incubation shifts of 2–4 days (Sealy 1976; Gaston 1992). The precocial chicks hatch within 12 hours of each other and weigh an average of 31 g one day post-hatching (Gaston 1992). The chicks are not fed in the burrows and leave the colony at night by running to join their parents at sea about 2–3 days after hatching. Median dates of chick departure differ significantly among colonies and years: in the 1990s, the earliest median date was recorded at Reef Island in 1995 and Limestone Island in 1996 (21 May) and the latest at Frederick Island in 1997 (3 June; Gaston and Harfenist 1998). The timing of departures was 8–11 days later off the northwest coast of Graham Island than off the east coast of Moresby Island; the difference is too large to be accounted for solely by variation in sea surface temperature around the archipelago (Gaston and Harfenist 1998).

Family groups swim quickly away from the breeding colony and are rarely seen inshore (Sealy 1975; Gaston 1992). Both parents feed their chicks at sea for at least a month until they are fully grown (Litvinenko and Shibaev 1987). *Synthliboramphus* is the only genus of seabirds in which the young are raised entirely at sea (Gaston 1994a).

Non-breeding birds visit breeding colonies at night; numbers peak during the second half of the incubation period (Gaston 1992). There is little activity by either breeders or non-breeders at the colonies by the end of June off eastern Moresby and early July off western Graham (Gaston 1992, 1994a).

The age at first breeding in Ancient Murrelets is 3–4 years (Gaston and Jones 1998). On Reef Island the age structure of the population at the beginning of the breeding season was 30% first-year birds, 29% non-breeding second- and third-year birds, and 41% breeding birds (Gaston 1994a). Mean annual survival of adults at Reef Island was estimated at 77% (Gaston 1990). Survival is relatively low for an alcid, but reproductive success is relatively high: almost all pairs lay a two-egg clutch and reproductive success up to the time that the chicks leave the colony is 1.44–1.69 chicks per laying pair (Vermeer and Lemon 1986; Rodway et al. 1988; Gaston 1994a). Most reproductive failure is caused by desertion of the eggs before incubation begins (Gaston and Jones 1998).

Site fidelity

Two types of site fidelity are considered for colonially nesting seabirds: fidelity to natal colony and fidelity to nest site. There is little information about fidelity of Ancient Murrelet to their natal colony as few birds banded as chicks have been recovered. Prospecting pre-breeders visit colonies close to their natal colonies and some recruitment to a non-natal colony has been observed (Gaston and Lemon 1996). Fidelity to nest site is difficult to determine as the birds nest in burrows and disturbance at their nests can cause desertion, but limited data suggest that there is some site fidelity at the burrow level. Burrows in which a pair bred successfully are more likely to be occupied in the following year than burrows in which eggs were deserted (Gaston 1992). Murrelets that have abandoned a burrow rarely return to that burrow (Gaston 1992).

Home range

Not applicable.

Movements and dispersal

The post-breeding season movements of Ancient Murrelets are largely unknown. Family groups immediately disperse from the waters around the breeding colony once the chicks have joined their parents at sea; within 6–8 hours of departure, family parties traveled an average of 13 km from the colony (Duncan and Gaston 1990). In British Columbia, Ancient Murrelet families from colonies off the east side of Moresby Island remained in offshore waters of Hecate Strait for several weeks (Duncan and Gaston 1990). Small numbers of birds have also been observed in offshore waters off Barkley Sound following the breeding season (Vermeer et al. 1987). During late summer and early fall, Ancient Murrelets are rarely seen in British Columbia's waters or elsewhere along coastal North America and their movements during this season are unknown (Campbell et al. 1990; Gaston 1994a). The birds reappear farther south at their wintering grounds in inshore waters around Vancouver Island by mid-October and off California by November (Campbell et al. 1990; Gaston 1994a). However, a small number of Ancient Murrelets move northward to winter in the Bering Sea and others winter throughout the breeding range (Gaston 1994a). Adults return to the marine waters adjacent to their colonies by March (Gaston 1992).

Ancient Murrelets are occasionally recorded from sites in the Interior of British Columbia; these are presumed to be windblown from the Coast (Campbell et al. 1990; Gaston 1994a).

Habitat

Structural stage

7: old forest

Important habitats and habitat features

Nesting

Ancient Murrelets require islands without alien mammalian predators. Colony areas and adjacent shorelines must also be free of most human disturbances. Ancient Murrelets require nearby marine areas with no lights or gill net fishery.

In British Columbia, Ancient Murrelet colonies are located on forested islands offshore from the main islands in the Queen Charlotte Islands/Haida Gwaii archipelago. Almost all Ancient Murrelets nest in burrows dug into the ground beneath mature Sitka spruce or western hemlock on seaward slopes or flat areas (Vermeer et al. 1984; Gaston 1992). On Frederick Island, nesting was densest on mossy slopes lacking understorey beneath hemlocks: 79%, 19%, and 2% of burrows were under western hemlock, Sitka spruce, or western redcedar, respectively (Vermeer et al. 1984). On Reef Island, most burrows are under >50% canopy cover (Gaston 1992). Most burrow entrances are found at the base of trees, stumps, or fallen logs; infrequently the birds nest in rock crevices or natural cavities in rotten logs (Vermeer and Lemon 1986; Gaston 1994a). Burrow tunnels are up to 2 m long (Vermeer and Lemon 1986; Gaston 1992). Ancient Murrelets excavate their own burrows or use burrows excavated by other individuals in previous years.

Most Ancient Murrelet burrows are located within 300 m of the ocean, but may be found up to 450 m from shore (Rodway et al. 1988, 1990, 1994). On Reef Island, peak burrow density was about 100 m from shore and densities were highest on slopes >30° (Gaston 1992). However, the birds also nest densely on flatter islands (Rodway et al. 1988, 1990, 1994). A summary of habitat plot data from colonies throughout the Queen Charlotte Islands/Haida Gwaii indicates that almost half of the plots had burrow densities below $0.33/m^2$ (G.W. Kaiser, unpubl. data).

Marine

During the breeding season, Ancient Murrelets are found primarily over the continental shelf and slope in waters with sea surface temperature between 4° and 20° C (Gaston 1994a). Highest densities are found near the shelf break (Vermeer et al. 1985); less frequently the birds are found in inshore waters (Gaston 1992). The waters adjacent to breeding colonies are used as gathering grounds in early evening and near dawn, but the birds are not usually seen near their colonies for most of the day. Important marine habitat features during late summer/early fall are unknown. In winter Ancient Murrelets are found over the continental shelf and slope in British Columbia, where aggregations of birds are found in areas of tidal upwelling that concentrates prey (Morgan et al. 1991; Gaston et al. 1993).

Conservation and Management

Status

The Ancient Murrelet is on the provincial *Blue List* in British Columbia. In Canada, it is considered a species of *Special Concern* (COSEWIC 2002).

Summary of ABI status in BC and adjacent jurisdictions (NatureServe Explorer 2002)

AK	BC	CA	OR	WA	Canada	Global
S4	S2S3B, S4N	S?	SZN	S3S4N	N3	G4

Trends

Population trends

The Canadian breeding population of Ancient Murrelets is approximately 256 000 pairs, all of which nest on the Queen Charlotte Islands/Haida Gwaii (Vermeer et al. 1997). Although population estimates in British Columbia are fairly accurate, estimates for much of the range are poor with only presence/absence data available from some sites and rough approximations of colony size at others (Springer et al. 1993). A best guess is that the B.C. population represents about one half of the world population (Gaston 1994a).

Ancient Murrelet populations have declined throughout the species' range due to depredation at the colonies by introduced mammals including rats, raccoons, and foxes (Bailey and Kaiser 1993). Some colonies, such as those on Lucy and Cox islands, have been extirpated by introduced predators (Gaston 1994b). The Aleutian Island population may have declined by 80% (Springer et al. 1993). Trend information is not available for the western Pacific populations, but breeding populations there have probably declined due to introduced predators; some small unprotected colonies in Japan, Korea, and China may be in danger of extirpation (Springer et al. 1993; Gaston 1994a). On the Queen Charlotte Islands/Haida Gwaii, all estimates from colonies without introduced predators indicate that breeding populations have increased by 0.2–9.5% annually since 1980 (Lemon and Gaston 1999). However, populations at those colonies with introduced predators have decreased at an annual rate of 1–23%. The total breeding population in the archipelago has declined by an estimated 50% in the last few decades (Gaston 1992). On Langara Island, the population declined from a historical level of about 200 000 pairs (Gaston 1992) to <15 000 pairs in 1993 (Harfenist 1994). Introduced rats are believed to be largely responsible for the decline; mortality caused by commercial gill net fisheries was also a contributor (Bertram 1995). Rats were eradicated from Langara Island in 1995 (Kaiser et al. 1997), but the Ancient Murrelet population had not shown evidence of recovery 5 years later (Drever 2000). Population declines or extirpations have also been attributed to rats at Kunghit, Lyell, Cox, Lucy, Murchison, and Bischof islands (Harfenist and Kaiser 1997). Introduced raccoons are believed responsible for declines on Limestone, Saunders, and Helgesen islands: the breeding population on Helgesen Island declined by over 80% over a 7-year period when 8–12 raccoons were present (Gaston and Masselink 1997).

Habitat trends

The presence of introduced mammalian predators on present, former, and potential colony islands has rendered those islands unsuitable for nesting Ancient Murrelets. With the exception of the presence of introduced species, potential suitable nesting habitat in British Columbia is likely relatively stable as the forests on colony islands have not been altered by industrial activities or urban development since the creation of Gwaii Haanas National Park Reserve/Haida Heritage Site. On Langara Island, a sports fishing lodge was constructed on an area historically used for nesting by Ancient Murrelets. On a regional level, there is no evidence that the availability of suitable breeding habitat limits the breeding population: some colony islands have large areas of unused suitable habitat (Gaston 1994b).

It is difficult to estimate the availability of suitable marine habitat for Ancient Murrelets. Suitable marine habitat adjacent to colonies may have increased with the decline in the commercial gill net fishery.

Threats

Population threats

Introduced mammalian predators pose the most serious immediate threat to nesting Ancient Murrelets in British Columbia (e.g., Gaston 1994b). Rats and raccoons have killed hundreds of thousands of adults and chicks (see "Population trends" above). At least one-half of the Ancient Murrelet colonies in the Queen Charlotte Islands/ Haida Gwaii are vulnerable to invasion by raccoons (Lemon and Gaston 1999). Rats are less likely to swim between islands but may reach new colonies on commercial or pleasure boats or ship wrecks.

Other significant threats are contaminants, exploitation of ocean resources, human recreation, and climate change (e.g., Vermeer et al. 1997). Oil pollution is the main contaminant threat to Ancient Murrelets: effect of oil on seabirds is well documented (e.g., Burger and Fry 1993). Ancient Murrelet carcasses comprised 2.4% of the birds washed up on Vancouver Island following the Nestucca oil spill (Rodway et al. 1989), but was one of most common species killed in oil spills in the Sea of Japan (Kazama 1971). Mortality from large episodic spills receive most of the attention, but impacts from chronic low-level pollution from ship operations such as bilge-flushing or leaking tanks may be more of a threat (Burger et al. 1997). Levels of organochlorine contaminants found in Ancient Murrelets nesting in British Columbia are probably below levels likely to seriously affect populations (Elliott et al. 1997).

The main issues of concern related to exploitation of ocean resources are bird/fisheries interactions and oil and gas development. The most serious threat to this species from the commercial fishery is that of bycatch in fishing nets. Significant numbers of Ancient Murrelets drowned in nets during gill net fisheries off Langara Island (Bertram 1995). Collisions with wires and ropes by birds attracted to lights on the boats caused additional mortality. Commercial and recreational overfishing of Ancient Murrelet prey species such as rockfish and herring may lead to a decrease in the availability of juvenile stages of these species for the birds (Vermeer et al. 1997). Oil and gas development in the oceans around the Queen Charlotte Islands/Haida Gwaii has the potential to increase mortality of Ancient Murrelets caused by oil or metal contamination as well as that caused by collisions around lights (Montevecchi et al. 1999). Wind turbines, such as those recently proposed for a site off Rose Spit, may also present a risk to migrating birds.

The activities of tourists involved in recreational boating or camping can damage the birds' habitat (see following section) or injure or kill to adults and chicks. The main risk is from campfires built on shorelines near colony sites. The birds are attracted to lights and will fly or run into fires; this was the main hunting technique used by the Haida (Ellis 1991). Lights around recreational boats or campsites will also disorient the birds.

Climate change has been indirectly linked to changes in seabird populations via alterations of their prey species' ecology (e.g., Anderson and Piatt

1999). Although there have been no studies of effects of climate change on Ancient Murrelets, warm marine waters during an El Niño event have been linked to a reduction in reproductive success in this species (Gaston and Smith 2001).

In the past Ancient Murrelet adults and eggs formed a significant part of the diet of Haida (Ellis 1991), but at present there is little threat to the breeding populations from human harvesting.

Habitat threats

The main threats to habitat are visitor activities that damage burrows and habitat destruction at sites from which the birds have been eradicated by introduced predators. On Langara Island, a sports fishing lodge was recently built on a former colony area, precluding full recovery of the Ancient Murrelet population on that island following the removal of the predators (Kaiser et al. 1997). In addition, development or activities that significantly alter the shoreline such as mariculture or recreational sites are a threat to the suitability of nesting habitat because chicks and adults require a relatively unobstructed route between their burrows and the ocean.

Forest harvesting at breeding colonies can be a significant threat; however, almost all of the currently active Ancient Murrelet breeding colony sites in British Columbia are protected or proposed for protection (i.e., WHAs).

Marine habitats adjacent to colonies and important feeding areas are threatened by oil pollution, oil and gas development, log sorts, and mariculture operations. The marine habitat can be rendered temporarily unsuitable for Ancient Murrelets by the presence of a commercial fishing fleet or a nearby sports fishing lodge.

Legal Protection and Habitat Conservation

The Ancient Murrelet, its nests, and eggs are protected in Canada and the United States from hunting and collecting under the *Migratory Birds Convention Act*. In British Columbia, it is protected from killing, or wounding, taking, and transporting under the *Wildlife Act*. However, Ancient Murrelets were traditionally an important food source for members of the Haida Nation and Haida can still legally hunt the birds for subsistence purposes.

In British Columbia, 16 of the 31 active nesting colonies are within Gwaii Haanas National Park Reserve/Haida Heritage Site and are protected under the *Canada National Parks Act*. Two additional colonies are within a B.C. Provincial Wildlife Management Area and covered under the *Wildlife Act*. One colony is within an ecological reserve and protected under the *Ecological Reserves Act*. The remaining 12 colonies have been designated as wildlife habitat areas under the *Forest Range and Practices Act*. Two colony islands (Lucy and Cox islands) from which Ancient Murrelets were eradicated by rats are on provincial Crown land.

Marine protected areas for the conservation of Ancient Murrelets can be created under the *Canada Wildlife Act*, although none have been designated to date. The *Canada National Marine Conservation Areas Act* came into force in June 2002. This act provides authority for the establishment of marine conservation areas. Marine bird bycatch in fisheries is covered under the *Fisheries Act*.

Identified Wildlife Provisions

Sustainable resource management and planning recommendations

The establishment of WHAs may not be adequate to address the threats faced by Ancient Murrelets. The link between terrestrial nesting habitats and adjacent and nearby terrestrial and marine habitats should be considered.

- Provide unobstructed access to the open ocean for adults and chicks departing the colony (i.e., no development such as log sorts, fishing lodges, mariculture operations, or recreation sites on shore, in intertidal areas or nearshore areas, or along opposite shores of non-colony islands).
- Provide undisturbed access to marine foraging grounds for adults during the breeding season.
- Discourage commercial and sports fishing activities in adjacent marine waters or in key foraging areas during the breeding season.

- ❖ Provide uncontaminated marine waters around colonies and foraging areas: to prevent exposure to chronic oil pollution from commercial or recreational boats, no mooring buoys in inshore areas around colonies.
- ❖ Provide colony and near-colony habitats free of light pollution.
- ❖ Maintain integrity of marine habitats of prey species.
- ❖ Restrict recreational use and access to colony sites (see "Additional Management Considerations").

Wildlife habitat area

Goal

Protect and maintain integrity of breeding colonies.

Feature

Establish WHAs at all extant and extirpated breeding colonies not already within national parks, national park reserves, ecological reserves, or wildlife management areas. Where Ancient Murrelet nesting colonies have been negatively impacted by introduced predators, WHAs should be established on former colony sites once the threat has been removed to allow the re-establishment of the colony and the recovery of the population.

Size

Generally between 5 and 50 ha but will vary with size and shape of nesting area.

Design

Ancient Murrelets nest around the periphery of islands and adults and chicks need unhindered access to the ocean. WHAs should include all areas with active nesting and the adjacent shoreline areas plus 200 m to maintain the quality and isolated nature of the forest and forest floor. In some cases, it may be necessary to include more area (possibly entire island) to ensure the integrity of a WHA is maintained (i.e., when active nesting occurs around the entire or significant proportion of an island and the only access for development would impact the colony such as impacting the integrity of the forest or forest floor).

General wildlife measures

Goals

1. Protect breeding colonies from development and disturbance.
2. Prevent mortality and disturbance of breeding birds and young on and adjacent to nesting areas.
3. Maintain important habitat features (i.e., intact forest structure and forest floor).
4. Prevent the introduction of non-native species.

Measures

Access

- Do not develop roads or access structures and restrict access to qualified biologists for monitoring populations.

Harvesting and silviculture

- Do not harvest or salvage timber. Do not allow development of any form in WHA or adjacent inshore waters.

Pesticides

- Do not use pesticides.

Recreation

- Do not develop recreation sites, trails, or structures.

Additional Management Considerations

Under the results based code (RBC), colonies can be protected from forest practices (including restrictions on establishing Ministry of Forests recreational facilities); however, it is not the mandate of the RBC to regulate recreational activities. Recreational activity at these colonies is considered a serious threat to this species. The following recommendations should be considered at colony sites.

Restrict access and do not allow recreational activities on colony islands.

Do not allow sports fishing lodges adjacent to colonies or on nearby shorelines.

Avoid activities involving lights or fires on nearby shorelines or in inshore waters around colonies.

Educate public on how to avoid disturbing nesting colonies. Clearly mark on marine and recreation maps with a notation that human access is prohibited at WHAs and other sites protected for these species.

Remove introduced species from colony islands. Ensure that non-endemic plants and animals are not introduced to colony islands. If necessary, reintroduce Ancient Murrelets to islands where colonies have been extirpated once introduced predators have been eradicated.

Information Needs

1. Population trend data have wide confidence intervals. Methodologies should be used to produce more precise population estimates and trends should be monitored.
2. The species' marine habitat is not well described. Important feeding areas should be determined.
3. Methods of eradicating introduced predators should be refined and those of attracting Ancient Murrelets back to areas from which they have been eradicated should be tested.

Cross References

Cassin's Auklet, Keen's Long-eared Myotis,"Queen Charlotte" Northern Saw-whet Owl, "Queen Charlotte" Hairy Woodpecker

References Cited

Anderson D. and J.F. Piatt. 1999. Community reorganization in the Gulf of Alaska following ocean climate regime shift. Mar. Ecol. Prog. Ser. 189:117–123.

Bailey, E.P. and G.W. Kaiser. 1993. Impacts of introduced predators on nesting seabirds in the northeast Pacific. *In* The status, ecology and conservation of marine birds on the North Pacific Ocean. K. Vermeer, K.T. Briggs, K.H. Morgan, and D. Siegel-Causey (editors). Can. Wildl. Serv., Ottawa, Ont., Spec. Publ., pp. 218–226.

Bertram, D.F. 1995. The roles of introduced rats and commercial fishing in decline of Ancient Murrelets on Langara Island, B.C. Conserv. Biol. 9:865–872.

Burger, A.E., J.A. Booth and K.H. Morgan. 1997. A preliminary identification of processes and problems affecting marine birds in coastal and offshore areas of British Columbia. Can. Wildl. Serv., Pac. and Yukon Reg. B.C. Tech. Rep. Ser. No. 277.

Burger, A.E. and D.M. Fry. 1993. Effects of oil pollution on seabirds in the northeast Pacific. *In* The status, ecology, and conservation of marine birds of the North Pacific. K. Vermeer, K.T. Briggs, K.H. Morgan, and D. Siegel-Causey (editors). Can. Wildl. Serv., Ottawa, Ont., Spec. Publ., pp. 254–263.

Campbell, R.W., N.K. Dawe, I. McTaggart-Cowan, J.M. Cooper, G.W. Kaiser, and M.C.E. McNall. 1990. The birds of British Columbia. Vol. 2. Nonpasserines. Diurnal birds of prey through woodpeckers. Royal B.C. Mus. and Can. Wildl. Serv., Victoria, B.C.

Committee on the Status of Endangered Wildlife in Canada (COSEWIC). 2002. Canadian species at risk. Available from: http://www.speciesatrisk.gc.ca

Drever, M. 2000. Status of Ancient Murrelet (*Synthliboramphus antiquus)* colony and upland birds following eradication of Norway rats (*Rattus norvegicus*) on Langara Island, Haida Gwaii. Report on file with the Can. Wildl. Serv., Pac. and Yukon Reg., Delta, B.C. 34 p. Unpubl.

Duncan, D.C. and A.J. Gaston. 1990. Movements of Ancient Murrelet broods away from a colony. Stud. Avian Biol. 14:109–113.

Elliott, J.E., P.A. Martin, and P.E. Whitehead. 1997. Organochlorine contaminants in seabird eggs from the Queen Charlotte Islands. *In* The ecology, status and conservation of marine and shoreline birds of the Queen Charlotte Islands. K. Vermeer and K.H. Morgan (editors). Can. Wildl. Serv., Ottawa, Ont. Occas. Pap. No. 93, pp. 137–146.

Ellis, D.W. 1991. The living resources of the Haida: birds. Report prepared for Parks Canada, Queen Charlotte City, B.C. Unpubl.

Gaston, A.J. 1990. Population parameters of the Ancient Murrelet. Condor 92:998–1011.

______. 1992. The Ancient Murrelet: a natural history in the Queen Charlotte Islands. T. & A.D. Poyser, London, U.K.

______. 1994a. Ancient Murrelet (*Synthliboramphus antiquus). In* The birds of North America, No. 132. A. Poole and F. Gill (editors). Acad. Nat. Sci., Philadelphia, Penn., and Am. Ornithol. Union, Washington, D.C.

______. 1994b. Status of the Ancient Murrelet, *Synthliboramphus antiquus*, in Canada and the effects of introduced predators. Can. Field-Nat. 108:211–222.

Gaston, A.J., H.R. Carter, and S.G. Sealy. 1993. Winter ecology and diet of Ancient Murrelets off Victoria, British Columbia. Can. J. Zool. 71:64–70.

Gaston, A.J. and A. Harfenist. 1998. Timing of breeding in Ancient Murrelets: comparison of east and west coasts of Haida Gwaii, B.C. Pac. Seabirds 25:65–67.

Gaston, A.J. and I.L. Jones. 1998. The auks. Oxford Univ. Press, New York, N.Y.

Gaston, A.J. and M.J. Lemon. 1996. A tale of two islands: comparisons of population dynamics of Ancient Murrelets at two colonies in Haida Gwaii, British Columbia. *In* Laskeek Bay Conservation Society: annual scientific report, 1995. A.J. Gaston (editor). Laskeek Bay Conserv. Soc., Queen Charlotte City, B.C., pp. 29–38.

Gaston, A.J. and M. Masselink. 1997. The impact of raccoons *Procyon lotor* on breeding seabirds in Englefield Bay, Haida Gwaii, Canada. Bird Conserv. Int. 7:35–51.

Gaston, A.J. and J.L. Smith. 2001. Changes in oceanographic conditions off northern British Columbia (1983-1999) and the reproduction of a marine bird, the Ancient Murrelet (*Synthliboramphus antiquus*). Can. J. Zool. 79:1735–1742.

Harfenist, A. 1994. Effects of introduced rats on nesting seabirds of Haida Gwaii. Can. Wildl. Serv., Pac. and Yukon Reg. B.C. Tech. Rep. Ser. No. 218.

Harfenist, A. and G.W. Kaiser. 1997. Effects of introduced predators on the nesting seabirds of the Queen Charlotte Islands. *In* The ecology, status and conservation of marine and shoreline birds of the Queen Charlotte Islands. K. Vermeer and K.H. Morgan (editors). Can. Wildl. Serv., Ottawa, Ont., Occas. Pap. No. 93, pp. 132–136.

Kaiser, G.W., R.H. Taylor, P. Buck, J.E. Elliott, G.R. Howald, and M.C. Drever. 1997. The Langara Island Seabird Habitat Recovery Project: eradication of Norway rats – 1993-1997. Can. Wildl. Serv., Pac. and Yukon Reg. B.C. Tech. Rep. Ser. No. 304.

Kazama, T. 1971. Mass destruction of *Synthliboramphus antiquus* by oil pollution of Japan Sea. Yamashina Chorui Kenkyusho Kenyuko Hokoku 6:389–398. Cited in Gaston, A.J. 1994a. Ancient Murrelet (*Synthliboramphus antiquus*). *In* The birds of North America, No. 132. A. Poole and F. Gill (editors). Acad. Nat. Sci., Philadelphia, Penn., and Am. Ornithol. Union, Washington, D.C.

Lemon, M.J.F. and A.J. Gaston. 1999. Trends in Ancient Murrelet populations since 1980. Bird Trends 7:22–25.

Litvinenko, N.M. and Yu.V. Shibaev. 1987. The Ancient Murrelet – *Synthliboramphus antiquus* Gm.: reproductive biology and raising of young. *In* Distribution and biology of seabirds of the Far East. N.M. Litvinenko (editor). Far East Sci. Centre, USSR Acad. Sci., Vladivostok. Cited in Gaston, A.J. 1994a. Ancient Murrelet (*Synthliboramphus antiquus*). *In* The birds of North America, No. 132. A. Poole and F. Gill (editors). Acad. Nat. Sci., Philadelphia, Penn., and Am. Ornithol. Union, Washington, D.C., pp. 72–84.

Montevecchi, W.A., F.K. Wiese, G. Davoren, A.W. Diamond, F. Huettmann, and J. Linke. 1999. Seabird attraction to offshore platforms and seabird monitoring from offshore support vessels and other ships. Literature review on monitoring designs. Environ. Stud. Res. Funds Rep. No. 138. Calgary, Alta.

Morgan, K.H., K. Vermeer and R.W. McKelvey. 1991. Atlas of pelagic birds of western Canada. Can. Wildl. Serv., Ottawa, Ont. Occas. Pap. No. 72.

NatureServe Explorer. 2002. An online encyclopedia of life [Web application]. Version 1.6. Arlington, Va. Available from: http://www.natureserve.org/explorer

Rodway, M.S. 1991. Status and conservation of breeding seabirds in British Columbia. *In* Seabird status and conservation: a supplement. J.P. Croxall (editor). Cambridge, U.K. ICBP Tech. Publ. No. 11, pp. 43–102.

Rodway, M.S. and M.J.F. Lemon. 1991. British Columbia Seabird Colony Inventory: report #7 – northern mainland coast. Can. Wildl. Serv., Pac. and Yukon Reg. B.C. Tech. Rep. Ser. No. 121.

Rodway, M.S., M.J. Lemon, and G.W. Kaiser. 1988. British Columbia Seabird Colony Inventory: report #1 – east coast Moresby Island. Can. Wildl. Serv., Pac. and Yukon Reg. B.C. Tech. Rep. Ser. No. 50.

______. 1990. British Columbia Seabird Colony Inventory: report #2 – west coast Moresby Island. Can. Wildl. Serv., Pac. and Yukon Reg. B.C. Tech. Rep. Ser. No. 65.

______. 1994. British Columbia Seabird Colony Inventory: report #6 – major colonies on the west coast of Graham Island. Can. Wildl. Serv., Pac. and Yukon Reg. B.C. Tech. Rep. Ser. No. 95.

Rodway, M.S., M.J.F. Lemon, J.-P. Savard, and R. McKelvey. 1989. Nestucca oil spill: impact assessment on avian populations and habitat. Can. Wildl. Serv., Pac. and Yukon Reg. B.C. Tech. Rep. Ser. No. 68.

Sealy, S.G. 1975. Feeding ecology of the Ancient and Marbled Murrelet near Langara Island, British Columbia. Can. J. Zool. 53:418–433.

______. 1976. Biology of nesting Ancient Murrelets. Condor 78:294–306.

Springer, A.M., A.Y. Kondratyev, H. Ogi, Y.V. Shibaev and G.B. van Vliet. 1993. Status, ecology, and conservation of *Synthliboramphus* murrelets and auklets. *In* The status, ecology and conservation of marine birds on the North Pacific Ocean. K. Vermeer, K.T. Briggs, K.H. Morgan, and D. Siegel-Causey (editors). Can. Wildl. Serv., Ottawa, Ont., Spec. Publ., pp. 187–201.

Vermeer, K., J.D. Fulton, and S.G. Sealy. 1985. Differential use of zooplankton prey by Ancient Murrelets and Cassin's Auklets in the Queen Charlotte Islands. J. Plankton Res. 7:443–459.

Vermeer, K., A. Harfenist, G.W. Kaiser, and D.N. Nettleship. 1997. The reproductive biology, status, and conservation of seabirds breeding on the Queen Charlotte Islands: a summary. *In* The ecology, status and conservation of marine and shoreline birds of the Queen Charlotte Islands. K. Vermeer and K.H. Morgan (editors). Can. Wildl. Serv., Ottawa, Ont., Occas. Pap. No. 93, pp. 58–77.

Vermeer, K. and M. Lemon. 1986. Nesting habits and habitats of Ancient Murrelets and Cassin's Auklets in the Queen Charlotte Islands, British Columbia. Murrelet 67:34–44.

Vermeer, K., S.G. Sealy, M. Lemon, and M.S. Rodway. 1984. Predation and potential environmental perturbances on Ancient Murrelets nesting in British Columbia. *In* Status and conservation of the world's seabirds. J.P. Croxall, P.G. Evans, and R.W. Schreiber (editors). Cambridge. ICBP Tech. Publ. No. 2, pp. 757–770.

Vermeer, K., S.G. Sealy, and G.A. Sanger. 1987. Feeding ecology of Alcidae in the eastern North Pacific Ocean. *In* Seabirds: feeding biology and role in marine ecosystems. J. Croxall (editor). Cambridge Univ. Press, Cambridge, U.K., pp. 189–227. Cited in Gaston, A.J. and I.L. Jones. 1998. The auks. Oxford Univ. Press, New York, N.Y.

BURROWING OWL

Athene cunicularia

Original prepared by Ernest E. Leupin

Species Information

Taxonomy

The Burrowing Owl belongs in the monotypic genus *Athene* (AOU 2002). There are 18 recognized subspecies in North and South America (Clark et al. 1978) of which two occur in North America: *A. cunicularia. floridana*, found in Florida, the Bahamas, and other Caribbean islands and *A. cunicularia hypugaea*, found throughout Mexico, western United States, and southwestern Canada (Cannings 1978).

Description

Small owl (23–28 cm) with round head lacking ear tufts; yellow eyes; body is dull brown with pale bars and spots; underside and breast are lighter and barred with brown; white-barred on tails and wings. Tail is short and wings are large. Males and females have a similar appearance.

Distribution

Global

The western subspecies (*A. cunicularia hypugaea*) is found from Canada to Panama. In Canada, it occurs in Manitoba, Saskatchewan, Alberta, and British Columbia.

British Columbia

In British Columbia, Burrowing Owls were historically found north to Kamloops, west to Ashcroft, and east to the Purcell Mountains, with populations in the Fraser River Delta (Hjertaas et al. 1995; Campbell et al. 1990). There are historical breeding records of wild birds in Creston, Merritt, Cache Creek, Kamloops, and the Lower Mainland. At present, the Burrowing Owl is confined to areas within the Thompson-Okanagan Plateau (D.J. Low, pers. comm.). In the 1980s and 1990s, reintroductions efforts took place in Oliver, Merritt, Cache Creek, and Kamloops. Released populations are concentrated in four main areas in the Thompson-Nicola Region: Lac du Bois Grasslands, Knutsford, Hamilton Commonage, and Quilchena.

The current extent of wild populations in British Columbia is mostly unknown. There are consistent reports of Burrowing Owls near Merritt, which suggest the existence of a small remnant population in the area. In all other areas, reports of wild Burrowing Owls are sporadic and isolated and thus cannot be considered as breeding populations. The occurrence of unbanded birds at release sites may indicate the presence of wild birds in the area, or could simply be progeny from released birds that were missed during previous banding efforts.

Non-breeding records have been made in the Beaver Valley west of Horsefly, Delta, Nanaimo, Campbell River, and the west Kootenays, although these are believed to be accidental events.

***Forest region and districts*[1]**

Southern Interior: Cascades, Kamloops, Okanagan Shuswap (Penticton)

Ecoprovinces and ecosections

CEI:	FRB (non-breeding)
GED:	FRL, NAL (non-breeding)
SIM:	EKT (non-breeding)
SOI:[2]	NIB, NOB, NOH, OKR, SOB, SOH (breeding), STU, THB

---

[1] Current breeding distribution.

[2] Breeding in SOI only.

Burrowing Owl

(Athene cunicularia)

Fort Nelson
Potential Habitat
Fort St. John
0 100 200 km
Smithers
Williams Lake
Vancouver
Nelson
Victoria

Note: This map represents a broad view of the distribution of potential habitat used by this species. The map is based on several ecosystem classifications (Ecoregion, Biogeoclimatic and Broad Ecosystem Inventory) as well as current knowledge of the species' habitat preferences. This species may or may not occur in all areas indicated.

Biogeoclimatic units

BG: xh1 (NOB, OKR, SOB), xh2 (THB), xw1 (NIB, THB), xw2 (FRB), xw3

CDF: mm (FRL, NAL)

IDF: dk1a (NIB, STU), xh1a (NOB, OKR, STU), xh2a (NIB, THB), xm (FRB)

PP: dh1 (SOH), xh1 (NOB, SOB), xh1a (NOB, OKR, SOB), dh2 (EKT)

Broad ecosystem units

BS, SS, (CF, ES on the coast)

Elevation

335–1250 m

Life History

The following life history information is specific to the western subspecies with emphasis on populations in Canada and North American prairie populations. Because detailed life history observations for wild birds in British Columbia are scarce, the data presented for British Columbia owls reflect observations made from captive-bred and released individuals in the Thompson-Nicola region unless otherwise indicated.

Diet and foraging behaviour

Burrowing Owls are opportunistic predators (Wellicome 1997; Leupin et al. 2000), preying primarily on insects and small mammals (Plumpton and Lutz 1993). During the day, owls prey on insects near the burrow; whereas, foraging for small mammals occurs predominately at night. For British Columbia's released population, small mammals comprised approximately 55% of the biomass in their diet and this proportion varied little throughout the year. In contrast, invertebrate prey consumption reflected the seasonal availability of the various species (Maser et al. 1971; Dickinson et al. 1994). Owls consumed coleopterans almost exclusively during the spring and early summer, but gradually shifted to grasshoppers as the season progressed. The diet of released owls is similar to that observed in wild populations (Leupin et al. 2000).

Several studies have identified small mammals as an important prey base for Burrowing Owls (Hjertaas et al. 1995). Vertebrate prey appear to be limiting during brood rearing (Wellicome 1997), which suggests that productivity is limited by low population levels of small mammals.

Reproduction

Owls return to breeding areas in April and May (Wellicome 1997; Leupin and Low 2000). In western North America, Burrowing Owls do not dig their own burrows, but rather occupy burrows made by fossorial mammals. Burrows are typically modified by enlarging burrow diameter and nest chambers (Coulombe 1971). Males choose a suitable burrow and advertise for females by calling. Burrows used by owls in British Columbia include those dug by Badger (*Taxidea taxus*), Coyote (*Canis latrans*), and Yellow-bellied Marmot (*Marmota flaviventris*) (Howie 1980; Bryant 1990). Nesting burrows and entrances are lined with cow manure chips prior to egg laying. The lining of burrows with manure is believed to be an evolutionary strategy to reduce predation by masking their scent to avoid detection (Coulombe 1971; Wellicome 1997).

Egg laying in wild populations typically begins in late April–late May (Coulombe 1971; Haug 1985). In British Columbia's captive bred/released populations, releases are purposely delayed to minimize mortality of released owls by migrating raptors. As a result pairing and nesting typically occurs between May and July (Leupin et al. 2000).

Mean clutch size for wild populations is between 3.6 (Plumpton and Lutz 1998) and 8.3 (Olenick 1987). Mean clutch size in released populations in British Columbia is 5.6 (Leupin et al. 2000). Young hatch after 21–30 days of incubation and emerge from the nest 20–25 days later. Fledglings begin moving between burrows shortly thereafter. Mean brood size for wild populations ranges between 2.1 and 6.3 (Hjertaas et al. 1995). In released populations in British Columbia, the mean brood size is 4.1 (Leupin et al. 2000).

Site fidelity

Philopatry and nest-site fidelity in Burrowing Owls is poorly understood. In Colorado, Plumpton and Lutz (1998) found that 92% of banded owls were never re-encountered the year following banding. However, a large proportion of the birds that returned (75% males and 63% females) occupied formerly used sites.

Home range

Home range for radio-collared males averaged 2.41 km^2 (range 0.14 km^2–4.81 km^2) in a foraging study near Saskatoon in 1989; although 95% of all detections were made within 600 m of the nest site (Haug and Oliphant 1990). A study conducted in southern Saskatchewan in 1997 reported significantly smaller home ranges (average 0.35 km^2, range 0.08 km^2 –0.49 km^2) (Sissons et al. 1998). The small home ranges observed were thought to have resulted from a superabundance of small mammals in the Canadian Prairies in that year (Wellicome et al. 1998).

In British Columbia, released captive-bred radio-collared males ($n = 2$) were observed mostly within 300 m of the nest site. Hunting movements were made at approximately 1 hour intervals and the average distance was 800 m (range 200–1500 m) (Leupin, unpubl. data).

Although this species has a clustered distribution, intra-specific competition has been reported if nests are too close (<110 m) (Hjertaas 1990). For released owls in British Columbia, the average distance between selected nesting burrows is 200 m and no territorial conflicts have been observed (D.J. Low, pers. comm.). One wild male was observed chasing off two released males at a release site where two captive-bred females were present (D.J. Low, pers. comm.).

Dispersal and migration

Juveniles disperse soon after fledging. Movements and distance away from the natal burrow increase in frequency and distance over time (Clayton 1997). Migration of birds from British Columbia typically occurs in September and October (Leupin et al. 2000); however, some of the released owls in British Columbia have remained over winter at, or near, release sites (Leupin et al. 2000).

Migration routes and areas used for overwintering are for the most part unknown (Wellicome 1997). Banded birds from Alberta and Saskatchewan have been relocated in Texas and Northern Mexico (G. Holroyd, pers. comm.). There are three recovery records (one each from Washington, Oregon, and California) for released birds banded in British Columbia. These recoveries suggest that B.C. owls use migration routes through the Great Basin in Washington and Oregon and into the southern coastal plain region of California (Leupin et al. 2000). However, these results should be interpreted with caution as they are from captive-bred birds and may not represent natural population's migration patterns.

Habitat

Structural stage

1: non-vegetated/sparse
2: herb

Important habitats and habitat features

Nesting

Important habitats include short grass, sparsely vegetated areas with available burrows in which to nest, as well as densely-vegetated areas adjacent to nesting areas to supply an adequate prey base (Wellicome 1997). In British Columbia, Burrowing Owls are associated with communities dominated by big sagebrush (*Artemisia tridentata*), antelope-brush (*Purshia tridentata*), and bunchgrass (*Agropyron* and *Festuca* spp.).

In the North American prairie, nesting habitat is strongly associated with ground squirrel (*Spermophilus* spp.), Black-tailed Prairie Dog (*Cynomys ludovicianus*), Yellow-bellied Marmot, Badger, Red Fox (*Vulpes vulpes*) and Coyote burrows and dens (Wellicome 1997; Desmond and Savidge 1998). In British Columbia, burrow availability is considered a limiting factor for this species.

Nest locations are usually located in areas where vegetation is shorter and less dense than the surrounding landscape (Green and Anthony 1989).

Green and Anthony reported nest locations in areas with short grass (0–10 cm) and weedy herbaceous species. Short grass is preferred perhaps because it enables the detection of predators, or because of availability of invertebrate prey.

Foraging

Burrowing Owls forage in a variety of habitats; however, foraging habitat close to the nest is important. Insects are taken from sparsely vegetated areas near the nest burrow (Wellicome 1997). Foraging for small mammals occurs in areas that are more densely vegetated. Haug and Oliphant (1990) found that nocturnal foraging was concentrated in roadside ditches, uncultivated fields, and ungrazed fields where taller vegetation prevailed. In British Columbia, released owls were observed foraging in a similar fashion. Night foraging was carried out mostly along riparian areas in ephemeral ponds and moisture seepage sites, and to a lesser extent along the sides of gravel roads.

Conservation and Management

Status

The Burrowing Owl is on the provincial *Red List* in British Columbia. Originally designated as *Threatened* in Canada (COSEWIC 1978), it is now considered *Endangered* (COSEWIC 2002). (See Summary of ABI status in BC and adjacent jurisdictions at bottom of page.)

Trends

Population trends

Population declines of the western subspecies have been reported throughout most of its range including serious declines in Canada (Holroyd 1998) and many parts of the United States (G. Holroyd, pers. comm.). A survey of 19 U.S. state wildlife agencies in 1992 reported declines in nine states; none reported increases (James and Espie 1997). In 1998, California reported the disappearance of 60% of known breeding groups initially reported in 1980 (Barclay et al. 1998). Texas also reported a 58% decline between 1990 and 1996 (Desmond and Savidge 1998).

In Canada, declines are well documented (Wellicome 1997). Generally, the population appears to be declining at a rate >10% annually (Holroyd 2000). In 2000, the population estimate for Alberta and Saskatchewan is 1000 pairs (Holroyd 2000). The rate of the decline in the last two decades has been sharp. Alberta reported declines from 1500 pairs in 1978 to 842 pairs in 1996 (Wellicome 1997). Significant declines were also reported in Saskatchewan from a program that relies on rural landowners to report Burrowing Owl sightings on their land. In 1988, 232 landowners reported 721 pairs whereas 485 landowners reported only 88 pairs in 1997 (Operation Burrowing Owl). In 1977, Manitoba's population was estimated at 100. In 2000, no pairs were reported and the species is now considered effectively extirpated (De Smet, pers. comm.).

In British Columbia, historical information suggests that Burrowing Owls were a regular breeding

Summary of ABI status in BC and adjacent jurisdictions (NatureServe Explorer 2002)

BC	AB	CA	ID	MT	OR	WA	Canada	Global
S1B, S2N	S2B, S2N	S2	S3S4	S3B, S2N	S2B	S3B S2N	N2B	G4

species. However, reports of wild breeding populations have not occurred since 1996. Reports of naturally occurring breeding pairs are a rare occurrence and the species was considered extirpated in British Columbia (Fraser et al. 1999). In 1989, a captive breeding and release program was initiated to reintroduce Burrowing Owls into historical sites. Since the inception of the reintroduction program, a total of 208 owls have been released (average = 26 birds per year). Ten years of reintroduction efforts of captive bred owls have not resulted in a self-perpetuating population.

Habitat trends

The general concern for Burrowing Owl populations in British Columbia is the availability of suitable grassland habitat. Grasslands make up <1.5% of the total land area in British Columbia (Chutter 1997). Suitable habitat for Burrowing Owls in British Columbia has declined. Native grasslands have been converted to agricultural crops, orchards, and urban areas, and remaining habitats are highly fragmented. However, some areas near Kamloops where crops were historically grown have been reverted to native grasslands. In addition, ground squirrel control programs have reduced burrow supply.

The historical diversity of vegetation, prey base, and symbiotic fossorial mammals is no longer sufficiently represented on the provincial landscape in a manner that satisfies the life-requisite needs of the Burrowing Owl (D.J. Low, pers. comm.).

Threats

Population threats

The sources of direct mortality include insecticide and rodenticide use, predation, vehicular collisions, and shooting (Wellicome 1997). The relative impacts of each can vary considerably between locations.

Insecticides can cause adult and juvenile mortality and affect reproductive performance because target species are often those that make up a significant portion of the owl's diet. In Saskatchewan, exposure to carbofuran, a systemic insecticide, at nesting sites resulted in a 54% reduction in the number of young produced and a 50% reduction in the proportion of pairs successfully fledging young relative to untreated areas (James and Fox 1987).

Some predator populations have increased considerably since historical times. The increases are believed to be associated with agricultural development. Main predators are Coyote and avian predators. Red-tailed Hawks (*Buteo jamaicensis*) and other raptors have benefited from the creation of perching structures (trees and fences) in grassland systems. In British Columbia, captive bred released birds are highly susceptible to predation during the first week after being released (Leupin and Low 2000).

Vehicular collisions also contribute to mortality, although the magnitude of the problem is difficult to assess. Wellicome (1997) suggested that the effects of vehicle mortality on Burrowing Owl populations in Alberta are low. However, the effect of vehicular collisions may be significant in areas where traffic is heavier or areas with higher road densities. In British Columbia, vehicular collisions do not appear to be of significance. Of 220 owls released since 1992, only one death is known to be from a vehicle collision.

Although mortalities associated with shooting do occur, they are difficult to quantify. Most shootings are likely accidental, as Burrowing Owls can easily be mistaken for ground squirrels or prairie dogs at a distance. Shootings are believed to be infrequent and of little effect to the overall population (Wellicome 1997).

Habitat threats

Elsewhere in their breeding range, the threats to this species have been clearly outlined (Hjertjaas et al. 1995; Holroyd 1998). In British Columbia, there is little supporting literature that details the factors responsible for decline (but see Howie 1980 and Bryant 1992). It is likely that the threats to Burrowing Owls in this province are commensurate with those observed elsewhere.

Grassland systems in British Columbia have been lost or fragmented as a result of forest encroachment, urban expansion,, and conversion of native grassland to agriculture (e.g., orchards). In addition to habitat loss and fragmentation, several anthropogenic activities have contributed to the degradation of the remaining habitats. These include burrowing mammal eradication, incompatible grazing regimes, early homestead stone removal from fields in ground squirrel habitats, fire suppression, and noxious weed introduction (Todd 1998; Leupin et al. 2000; D.J. Low, pers. comm.). These activities have contributed to decreases in burrow availability, loss of horizontal vegetation heterogeneity, decreases in vertebrate prey base, and increased predation, all of which contribute to elevated mortality rates (D.J. Low, pers. comm.). Howie (1980) identified the reduction in Badger populations as a main factor responsible for the Burrowing Owl decline.

Legal Protection and Habitat Conservation

Raptors are not covered by the federal *Migratory Bird Convention Act*. In British Columbia, the Burrowing Owl is designated as an Endangered Species under the *Wildlife Act*. It is one of a few species listed in Section 34b of the *Act* for which the nest is protected year-round, regardless of whether it is active.

Due to the Burrowing Owl's national status, a national recovery team was established to direct research and conservation activities towards downlisting the species in Canada. A recovery team was also established in British Columbia. The BC Recovery Team has forged strong working relationships with range landowners to promote Burrowing Owl habitat stewardship. The commitments made by local landowners ensure habitat availability and sustainable management strategies that incorporate habitat requirements of the Burrowing Owl. These commitments are verbal and are not legally binding. Unless covenant documents are prepared on private lands, the commitment to protect Burrowing Owl habitat may not provide for long-term protection of the habitat.

Only a small proportion of existing Burrowing Owl habitat is under Crown ownership. Some habitat occurs within protected areas such as the Lac du Bois Grasslands Provincial Park and the Osoyoos Desert Centre. Range use plans under the results based code (RBC) may provide some degree of habitat conservation on Crown land, provided these plans contain objectives and strategies for maintaining important habitat features outlined in this account (see below).

Current legislated protection and protected areas have resulted in relatively small, fragmented habitat pockets that are embedded in a larger matrix of privately owned properties; the latter not being subject to RBC guidelines. Despite extensive research and recovery efforts, as of yet no effective management measures have been proven to stabilize or increase Burrowing Owl population numbers in British Columbia.

Identified Wildlife Provisions

Sustainable resource management and planning recommendations

- Consider fossorial mammals and availability of suitable burrows. Protection of grassland habitat is not sufficient unless burrows are available.
- Maintain connectivity of grassland habitats by managing and protecting remnant habitats throughout the Great Basin.
- Ensure long-term availability of suitable habitats through management strategies aimed at increasing burrowing mammal populations.
- Within sites maintain a mosaic of grassland habitat in a variety of structural stages.

Wildlife habitat area

Goal

Maintain or recover nesting and foraging habitat for Burrowing Owls in appropriate juxtapositions.

Feature

Establish WHAs at active nest sites as recommended by the Burrowing Owl Recovery Team.

Size

Roughly 300 ha but will depend on site-specific factors, such as habitat suitability and number of breeding pairs.

Design

WHAs should include the nest site (burrow), roost burrows, and approximate home range. Based on home range studies, an area of 1000 m radius around the nest site is recommended (Haug and Oliphant 1990; Sissons et al. 1998). Where more than one family occurs in close proximity, the WHA should be centred on all nest locations and the total area increased to at least 490 ha (1250 m radius).

The WHA should be designed to prevent disturbance to the nest sites but should also contain important areas for foraging (e.g., tall grass areas and riparian areas without trees or large shrubs).

General wildlife measure

Goals

1. Prevent physical damage to burrows.
2. Maintain both nesting and foraging habitat structure and critical features (i.e., ground cover and tall grass for prey species as well as short grass areas for nesting Burrowing Owls).
3. Minimize disturbance to nesting sites.
4. Minimize road mortality.
5. Minimize threat of predation.
6. Prevent forest encroachment.

Measures

Access

- Restrict vehicular access within 500 m of nest sites during the breeding season (1 April to 31 July). Limit all vehicular access year-round within 150 m of known nest locations.
- Do not construct roads or trails.

Pesticides

- Do not use pesticides.

Range

- Plan livestock grazing to maintain desired structure of plant community, desired stubble height, and browse utilization. If damage from livestock is found to be degrading vegetative structure, fencing may be required. Consult MWLAP for fencing arrangements.
- Do not graze during the breeding season (1 April through 31 July).
- Do not concentrate livestock within WHA.
- Maintain tall grass structure in areas designated to provide foraging habitat.
- Maintain dense understorey with sufficient residual cover suitable for small mammals in riparian areas through methods such as placement of salt licks, water developments, fencing, or herding.
- Do not mow during the breeding season (April through July).

Recreation

- Do not develop recreational sites or trails.
- Do not use recreational vehicles (i.e., off-road vehicles) within WHA.

Additional Management Considerations

Where possible, control forest encroachment into natural grassland habitat with controlled prescribed burning. Fall burning or manual removal of seedlings and saplings is preferred in Burrowing Owl WHAs.

The current shortage of burrows has resulted from the historical reduction of fossorial mammal populations in the southern Interior of British Columbia. Currently, artificial burrows (nesting and security) are placed in areas containing suitable nesting and foraging habitats. Although artificial burrows are an effective short-term enhancement technique, they should not be considered an ultimate solution (Bryant 1990). Yellow-bellied Marmot (*Marmota flaviventris*), Columbia Ground Squirrel (*Spermophilus columbianus*), and Badger (*Taxidea taxus*) are three native fossorial species that still persist, albeit in low numbers, in British Columbia's grasslands. Therefore, any management activities that benefit these populations will ultimately be beneficial to Burrowing Owls.

Despite intensive efforts to determine the reasons for the decline of Burrowing Owl populations, no significant positive changes have been achieved to permanently increase populations of Burrowing Owls in Canada. Return rates for banded owls are relatively low (Hjertaas 1992), which suggest that mortality rates during migration and wintering may be an important factor for Canadian populations. International efforts to ensure winter and migration habitat availability should become a priority to complement recovery efforts in British Columbia and other Canadian provinces.

Information Needs

1. Migratory routes.

Cross References

Badger, "Columbian" Sharp-tailed Grouse, Great Basin Spadefoot, Long-billed Curlew, Western Rattlesnake

References Cited

American Ornithologists' Union (AOU). 2002. Check-list of North American birds. Am. Ornithol. Union, Washington, D.C.

Barclay, J., C. Bean, D. Plumpton, and B. Walton. 1998. Burrowing Owl conservation in California: issues and challenges. *In* Abstr. 2nd Int. Burrowing Owl Symp., Sept. 1998. Ogden, Utah.

Bryant, A.A. 1990. A recovery plan for the Burrowing Owl in British Columbia. B.C. Min. Environ., Lands and Parks, Victoria, B.C.

______. 1992. Burrowing Owls in the South Okanagan: status and opportunities. B.C. Min. Environ., Lands and Parks, Victoria, B.C. Unpubl. rep.

Campbell, R.W., N.K. Dawe, I. McTaggart-Cowan, J.M. Cooper, G.W. Kaiser, and M.C.E. McNall. 1990. The birds of British Columbia. Vol. II: Nonpasserines. Diurnal birds of prey through woodpeckers. Royal B.C. Mus., Victoria, B.C.,and Can. Wildl. Serv., Delta, B.C. 636 p.

Cannings, R. 1978. Burrowing Owl in British Columbia. B.C. Min. Environ., Lands and Parks, Victoria, B.C. Unpubl. rep.

Chutter, A. 1997. BC grasslands stewardship: A guide for ranchers and recreation users. B.C. Min. Environ., Lands and Parks, Victoria, B.C. Stewardship Ser.

Clark, R.J., D.G. Smith, and L.H. Kelso. 1978. Working bibliography of owls of the world. Natl. Wildl. Fed., Sci. Tech. Ser. No 1., Washington, D.C.

Clayton, K.M. 1997. Post-fledging ecology of Burrowing Owls in Alberta and Saskatchewan: dispersal, survival, habitat use and diet. M.Sc thesis. Univ. Saskatchewan, Saskatoon, Sask.

Committee on the Status of Endangered Wildlife in Canada (COSEWIC). 2002. Canadian Species at Risk. www.speciesatrisk.gc.ca

Coulombe, H.N. 1971. Behaviour and population ecology of the Burrowing Owl, *Speotyto cunicularia*, in the Imperial Valley. Condor 73:162–176.

Desmond, M.J. and J.A. Savidge. 1998. Burrowing Owl conservation in the Great Plains, *In* Abstr. 2nd Int. Burrowing Owl Symp., Sept. 1998. Ogden, Utah.

Dickinson, T.E., E.E. Leupin, V. Collins, and M.J. Murphy. 1994. An ecological assessment of sites used for the re-introduction of Burrowing Owls near Kamloops, B.C. in 1993. B.C. Min. Environ., Lands and Parks, Kamloops, B.C. Unpubl. rep.

Fraser, D.F., W.L. Harper, S.G. Cannings, and J.M. Cooper. 1999. Rare birds of British Columbia. B.C. Min. Environ., Lands and Parks, Wildl. Br. and Resour. Inventory Br., Victoria, B.C. 244 p.

Green, G.A. and R.G. Anthony, 1989. Nesting success and habitat relationships of Burrowing Owls in the Columbia Basin, Oregon. Condor 91:347–354.

Haug, E.A. 1985. Observations on the Breeding Ecology of Burrowing Owls in Saskatchewan. M.Sc. thesis. Univ. Saskatchewan, Saskatoon, Sask.

Haug, E.A. and L.W. Oliphant 1990. Movements, activity patterns and habitat use of Burrowing Owls in Saskatchewan. J. Wildl. Manage. 54(1):27–35.

Hjertaas, D. 1990. National recovery plan for the Burrowing Owl. Prepared for the Committee for the Recovery of Nationally Endangered Wildlife (RENEW). 51 p.

Hjertaas, D., S. Brechtel, K. De Smet, O. Dyer, E. Haug, G. Holroyd, P. James, and J. Schmutz. 1995. National Recovery Plan for the Burrowing Owl. Recovery of Nationally Endangered Wildlife Comm., Ottawa, Ont. Rep. No. 13. 33 p.

Holroyd, G. 1998. The status of Burrowing Owls in Canada. *In* Abstr. 2nd Int. Burrowing Owl Symp., Sept. 1998. Ogden, Utah.

Howie, R.R. 1980. The Burrowing Owl in British Columbia. *In* Threatened and endangered species and habitats in British Columbia and the Yukon. R. Stace-Smith, L. Johns, and P. Joslin (editors). B.C. Min. Environ., Victoria, B.C., pp. 85–95.

James, P.C. and G.A. Fox. 1987. Effects of some insecticides on productivity of Burrowing Owls. Blue Jay 45:65–71.

James, P.C. and R.H.M. Espie. 1997. Current status of the Burrowing Owl in North America: an agency survey. *In* Proc. Burrowing Owl Symp., Sacramento, Calif. J.L. Lincer and K. Steenhoff (editors). J. Raptor Res. Spec. Publ. 9.

Leupin, E.E. and D.J. Low. 2000. A summary and assessment of the Burrowing Owl re-introduction effort in the Thompson-Nicola Region of British Columbia. *In* Abstr. 2nd Int. Burrowing Owl Symp., Sept. 1998. Ogden, Utah.

Leupin, E.E., D.J. Low, M. Mackintosh, and D. Brodie. 2000. Stewardship and the reintroduction of captive-bred Burrowing Owls into British Columbia: a feasible option for recovery? *In* Proc. Conf. on the biology and management of species and habitats at risk. L.M. Darling (editor). Kamloops, B.C., Feb. 15–19, 1999. B.C. Min. Environ., Lands and Parks, Victoria, B.C., and Univ. Coll. Cariboo, Kamloops, B.C., pp. 909–914.

Maser, C.E., W. Hammer, and S.H. Anderson 1971. Food habits of the Burrowing Owl in central Oregon. Northwest Sci. 45:19–26.

NatureServe Explorer. 2002. An online encyclopaedia of life. Version 1.6. NatureServe. Arlington, VA. Available at http://www.natureserve.org/explorer/

Olenick, B. 1987. Reproductive success of Burrowing Owls using artificial nests in southeastern Idaho. Eyas 10:38.

Plumpton, D.L. and R.S. Lutz. 1993. Prey selection and food habits of Burrowing Owls in Colorado. Great Basin Natur. 53:299–304.

_____. 1998. Philopatry and nest site re-use by Burrowing Owls: implications and productivity. In Abstr. 2nd Int. Burrowing Owl Symp., Sept. 1998. Ogden, Utah.

Sissons, R., K. Skalise, and T. Wellicome. 1998. Nocturnal foraging habitat use of the Burrowing Owl in a heavily cultivated region of southern Saskatchewan. 1998. *In* Abstr. 2nd Int. Burrowing Owl Symp., Sept. 1998. Ogden, Utah.

Todd, L.D. 1998. Post-fledging dispersal and mortality of juvenile Burrowing Owls on the Regina Plain, Saskatchewan: preliminary results. *In* Abstr. 2nd Int. Burrowing Owl Symp., Sept. 1998. Ogden, Utah.

Wellicome, T.I. 1997. Status of the Burrowing Owl (*Athene cunicularia hypuaea*) in Alberta. Alberta Environ. Prot., Wildl. Manage. Div., Edmonton, Alta. Wildl. Status Rep. 11. 21 p.

Wellicome, T.I., G.L. Holroyd, K. Scalise, and E.R. Wiltse. 1998. The effects of predator exclusion and food supplementation on Burrowing Owls (*Athene cunicularia*) population change. *In* Proc. 2nd Int. Symp. Biology and conservation of owls in the northern hemisphere. J.R. Duncan, D.H. Johnson and T.H. Nichols (editors). U.S. Dep. Agr. For. Serv., Gen. Tech. Rep. NC-190.

Personal Communications

De Smet, K. 1999. Min. Natural Resources, Winnipeg, Man.

Low, D.J. 2000. Min. Environment Lands and Parks, Kamloops, B.C.

FLAMMULATED OWL

Otus flammeolus

Original prepared by R.J. Cannings
and Astrid M. van Woudenberg

Species Information

Taxonomy

The Flammulated Owl is the only New World *Otus* species that is part of the Old World subgenus *Scops* and is not closely related to other North American *Otus* species. One to six subspecies are recognized (Hekstra 1982; del Hoyo et al. 1999). Populations at the northern range, including those in British Columbia, are generally separated as *O. flammeolus idahoensis* (e.g., Cannings 1998), although the species is sometimes treated as monotypic (e.g., del Hoyo et al. 1999). Geographical differences include the amount of reddish pigment in the plumage (increasing southward with increasing pine dominated habitats; conversely, increasing grey with increasing Douglas-fir heading north) and wing length (increasing northward with increasing migration distances), although the differences may be clinal and not useful for subspecific taxonomy (del Hoyo et al. 1999).

Description

Small owl (16–19 cm in length) with variegated red and grey plumage. Small indistinct ear tufts. Brown eyes.

Distribution

Global

The Flammulated Owl breeds in the western mountains of North America from British Columbia south to Mexico and northern Central America. In winter, populations in Canada and the United States migrate to the southern portions of the breeding range (McCallum 1994a).

British Columbia

In the breeding season (May–September), the Flammulated Owl occurs from the Okanagan and Similkameen valleys north through the Nicola and Thompson valleys and the drier parts of the Fraser-Chilcotin valleys to Alexis Creek in the west and McLeese Lake in the north (Roberts and Roberts 1995; Waterhouse 1996, 1997; K. Wright, pers. comm.). It is also found in the Rocky Mountain Trench north at least to Radium Hot Springs.

The species occurs in the elevational band characterized by dry Douglas-fir (*Pseudotsuga menziesii*) forests along the upland slopes of the major drainages of the southern region of the province. Confirmed records are from the Fraser River between Williams Lake (M. Waterhouse, pers. comm.) and Lytton (Texas Creek) (van Woudenberg 1998); North Thompson Valley (Christie 1996; Christie and Low 1996); Merritt, Princeton, and Nicola valleys (van Woudenberg and Christie 2000); South Thompson and Okanagan valleys (Cannings and Booth 1997); and the southern Rocky Mountain Trench to Radium Hot Springs (CDC 1998; van Woudenberg et al., in prep.).

Forest region and districts

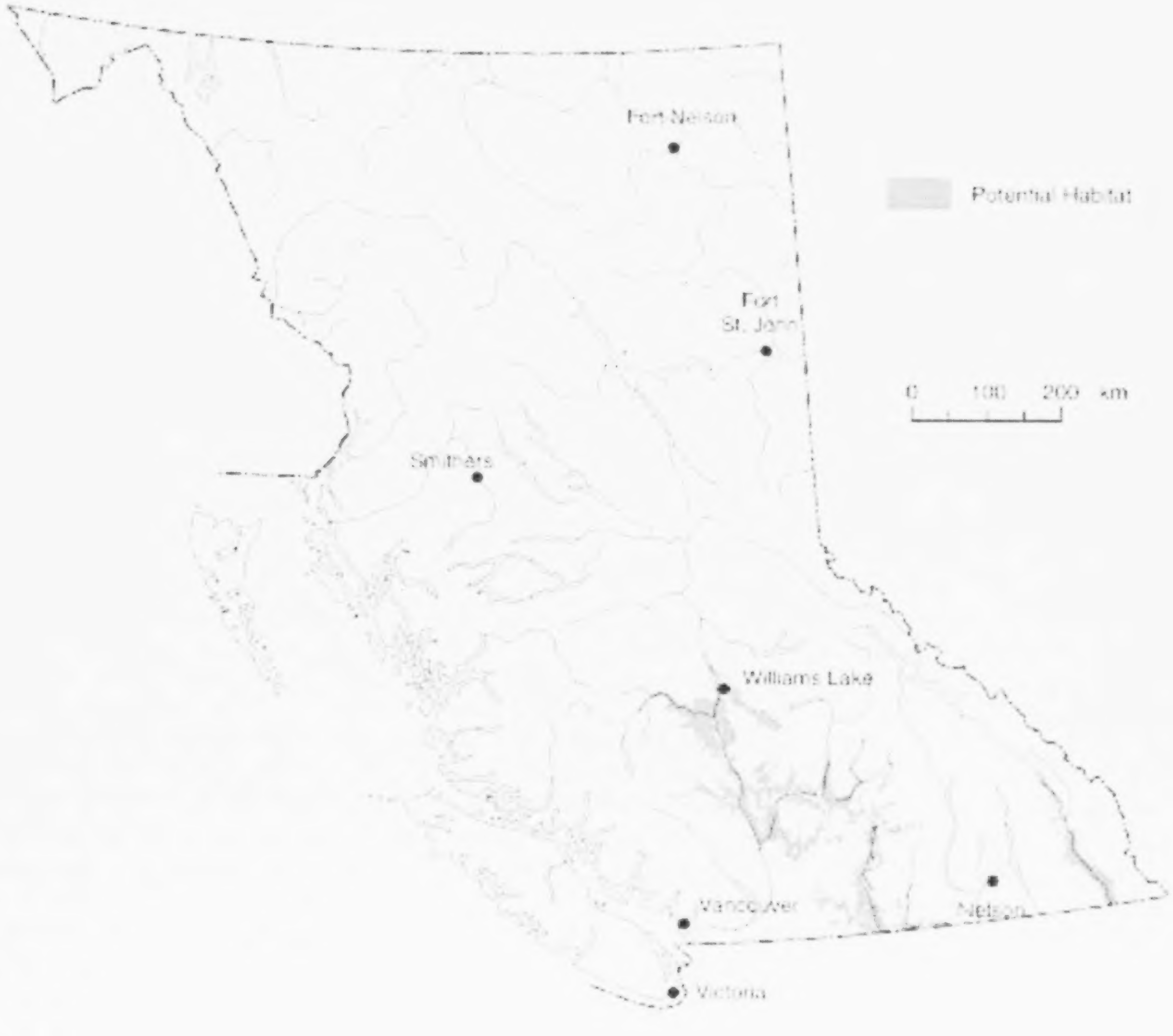
Southern Interior: 100 Mile House, Cascades, Central Cariboo, Chilcotin, Kamloops, Okanagan Shuswap, Rocky Mountain

Ecoprovinces and ecosections

CEI:	CAB, CCR, CHP, FRB, QUL
SOI:	GUU, NIB, NOB, NOH, NTU, OKR, PAR, SCR, SHB, SOB, SOH, STU, THB, TRU
SIM:	EKT, EPM, MCR, UCV

Flammulated Owl

(Otus flammeolus)


Fort Nelson
Potential Habitat
Fort St. John
0 100 200 km
Smithers
Williams Lake
Vancouver
Nelson
Victoria

Note: This map represents a broad view of the distribution of potential habitat used by this species. The map is based on several ecosystem classifications (Ecoregion, Biogeoclimatic and Broad Ecosystem Inventory) as well as current knowledge of the species' habitat preferences. This species may or may not occur in all areas indicated. More detailed maps are available for this species from the Ministry of Sustainable Resource Management.

Biogeoclimatic units

BG: xh1, xh2, xw, xw1, xw2

PP: dh1, dh2, xh1, xh2

IDF: dk1, dk2, dk3, dk4, dm, dm1, dm2, mw1, mw2, un, xh1, xh1a, xh1b, xh2, xh2a, xh2b, xm, xw, xw2

Broad ecosystem units

DF, DP, PP

Elevation

North America: 375 (Campbell et al. 1990)–2700 m (Winter 1974)

British Columbia: Kamloops and Merritt 400–1375 m (van Woudenberg et al. 1995)

Life History

Diet and foraging behaviour

Insectivorous. Prey consists of larger insects, including moths, katydids, crickets, and beetles, often taken on the wing from high grass or shrubs in forest openings, or gleaned from forest canopies.

Reproduction

Breeds in British Columbia between May and August. Generally, one clutch is laid per year. Clutch size is typically two to four eggs; young may fledge from mid-July through mid-August; fledglings depend on parents for 4–5 weeks.

The Flammulated Owl is a secondary cavity nester, nesting in natural cavities or those excavated by Pileated Woodpeckers (*Dryocopus pileatus*) or Northern Flickers (*Colaptes auratus*) (van Woudenberg 1999). Alternative cavities have been used for nesting in the same tree in successive years and alternative trees have been used within the same foraging areas. The Barred Owl (*Strix varia*) is a significant predator in some localities, and may be a particular risk to Flammulated Owl fledglings.

Site fidelity

This species shows strong fidelity to breeding areas (Reynolds and Linkhart 1992). Males typically return to territories.

Home range

Home range size and dispersal behaviour of Flammulated Owls are not well understood in British Columbia, although foraging distances have been as far as 586 m from nest sites. Home range areas have been recorded as large as 15.9 ha on average (McCallum 1994b); however, 2.2–3.7 ha were roughly estimated for two nest sites in British Columbia (van Woudenberg 1992).

Dispersal and movements

Often forages within 300 m of nest site during breeding season.

Neotropical migrant. Winters in Mexico and northern Central America (McCallum 1994a).

Habitat

Structural stage

6: mature forest
7: old forest

Important habitats and habitat features

Nesting

Important nesting habitat includes multi-age class stands with multiple canopy layers, including a veteran tree component for nesting and roosting. Wildlife trees with large live branches (class 1) provide considerable security cover for roosting, calling, and snags with cavities (wildlife tree classes 3–6) provide nesting habitat. Occasionally, nests can be found in class 7 wildlife trees, particularly if the tree species is ponderosa pine (*Pinus ponderosa*); however, successful recruitment of young is unknown. Regenerating thickets of Douglas-fir provide security cover if they are adjacent to grassy or shrub-dominated openings that provide foraging habitat. Flammulated Owls do not occupy pre-commercially thinned stands or areas where silvicultural treatments leave evenly spaced, open stands, probably because even-aged, single canopy layer stand structure does not provide the density required for security cover (van Woudenberg 1999).

Recruitment of large diameter ponderosa pine for nest trees may be critical for sustainability of local populations. Large diameter pine tend to be more stable as snags than smaller trees and other species, and may enhance productivity if predation of nests is reduced by high cavities in smooth, hard snags with no bark. Flammulated Owls selected large diameter ponderosa pine disproportionately to Douglas-fir for nesting (van Woudenberg 1992; Christie and Low 1996).

In Oregon, Pileated Woodpecker cavities were preferred by Flammulated Owls in comparison with Northern Flicker cavities (Bull et al. 1990). In British Columbia, 67% of the Flammulated Owl nest trees were in ponderosa pine and 28% were in Douglas-fir (van Woudenberg 1999). Of the nest trees studied in Oregon, 91% were dead and in British Columbia, 75% were dead (Bull et al. 1990; van Woudenberg 1999).

Because Flammulated Owls nest in Pileated Woodpecker and Northern Flicker cavities, it is useful to consider the nesting requirements of these two species in forests where Flammulated Owls occur (see Appendix 12).

Pileated Woodpeckers in northwestern Montana selected mainly western larch (*Larix occidentalis*) and rarely Douglas-fir for nest trees (McClelland and McClelland 1999). They used ponderosa pine where groves were almost entirely composed of ponderosa pine and Douglas-fir. In riparian forests, nest trees were in large black cottonwood (*Populus balsamifera*) and all aspen (*Populus tremuloides*) nest trees were in monospecific groves of aspen (McClelland and McClelland 1999). In the Okanogan National Forest, Northern Flickers selected ponderosa pine and western larch in greater proportion than Douglas-fir or other species (Madsen 1985). In south-central British Columbia, Pileated Woodpeckers nested exclusively in trembling aspen (Harestad and Keisker 1989). Northern Flickers preferred trembling aspen to conifers near Riske Creek (Wiebe 2001).

In British Columbia, the diameter at breast height (dbh) of Flammulated Owl nest trees ($n = 11$) was 63.8 cm ± 13.5 (after van Woudenberg 1992). The mean dbh varied slightly between tree species, although the range was not dissimilar (Table 1).

Table 1. Dbh (mean ± SD) (cm) of Flammulated Owl nest trees (after van Woudenberg 1992)

Tree species	*n*	dbh	Range
Ponderosa pine	7	65.7 ± 12.8*	46.2–81.2
Douglas-fir	4	60.6 ± 14.6	49–82

* Weighted mean and pooled standard deviation

Nests are often located within and/or near foraging habitat, characterized by small forest openings (<1 ha) adjacent to Douglas-fir thickets and/or large veteran Douglas-firs or ponderosa pines with heavy branching for security.

Foraging

Understorey structure may be important in forest openings for foraging habitat. Flammulated Owls were not observed nesting in areas they had previously occupied after grazing had reduced grasses <10 cm (van Woudenberg 1999).

Conservation and Management

Status

The Flammulated Owl is on the provincial *Blue List* in British Columbia. It is designated as a species of *Special Concern* in Canada (COSEWIC 2002).

Summary of ABI status in BC and adjacent jurisdictions (NatureServe Explorer 2002)

BC	ID	MT	OR	WA	Canada	Global
S3S4B, SZN	S3B, SZN	S3B, SZN	S4B	S3B, SZN	N3B	G4

Trends

Population trends

Current population levels and distribution are poorly known, and since historical populations are completely unknown, trends are difficult to establish. The species is more widespread than previously reported, because of increased search effort in the past decade rather than any real population increase.

The total Flammulated Owl population in British Columbia, including breeders and non-breeders, may be somewhat greater than 3000 birds (van Woudenberg 1999). While minimum population estimates have been refined tremendously over the past 20 years, absolute densities cannot be measured using census results alone, because these only provide minimum numbers of calling birds. Only a nesting pair is clearly indicative of breeding activity and breeding habitat suitability, and relatively few nests have been found. There is thus little information regarding population sizes and no information regarding population trends for the province.

Habitat

Likely declining due to harvesting of old-growth forest and firewood cutting.

Threats

Population threats

The low fecundity of the Flammulated Owl (clutch sizes of two to four) (McCallum 1994b) and its dependence on old-growth features of dry montane forests compound an inherent vulnerability regarding long-term population sustainability.

Habitat threats

The greatest immediate risk to the Flammulated Owl is loss of critical nesting, security, and foraging habitat features from forest management (i.e., harvesting, spacing, thinning, road construction, pest management). A secondary threat is loss of grass and shrub components of foraging habitat by livestock grazing during key breeding periods. In addition, snag removal for safety reasons or for firewood is also a threat. Long-term major threats are recruitment and maintenance of old-growth habitat features, particularly large diameter ponderosa pine snags with cavities. Fire suppression is also a concern as it may reduce foraging habitat over the long term.

Suitable silvicultural treatments and grazing regimes can maintain and encourage regeneration of habitat features.

Legal Protection and Habitat Conservation

The Flammulated Owl, its nests, and its eggs are protected from direct persecution by the provincial *Wildlife Act*.

There are several parks within the range of this species that may contain suitable habitat.

Wheeler Mountain has the highest nesting density of Flammulated Owls documented in British Columbia and is within the Lac du Bois Protected Resource Management Zone (Kamloops LRMP Team 1995). Timber harvesting is not permitted within the protected area but grazing is allowed. There remains the concern that stand structure in the protected area will change without proper management, to the detriment of Flammulated Owl habitat quality. Season-long grazing during the breeding period may reduce current available shrub and grass structure.

The general legal provisions of the results based code, such as wildlife tree retention areas and old growth management areas (OGMAs) provide non-specific protection for forest birds and nesting habitat, including the Flammulated Owl (P. Holman, pers. comm.). Old growth management area considerations for this species could consist of awareness of the preference for ponderosa pine, prescribed treatments may be needed to maintain appropriate stand structure, and grazing should be moderated to maintain grasses >10 cm height on average.

Ungulate winter range provisions likely provide some habitat. Flammulated Owl records in the Cariboo-Chilcotin were completely within ungulate winter ranges (M. Waterhouse, pers. comm., cited by Van Woudenberg 1999).

Identified Wildlife Provisions

Sustainable resource management and planning recommendations

Because this species is largely dependent on woodpecker cavities (Northern Flickers and Pileated Woodpeckers) for nest sites, management practices that benefit woodpeckers will also enhance habitat for the Flammulated Owl.

The objective for this species is to maintain wildlife trees and green recruitment trees for nesting across the breeding range and over time. Consider WTR area and OGMA objectives for this species in the following forest districts: Kamloops, Okanagan Shuswap, Cascades, Central Cariboo, 100 Mile House, Chilcotin, and Rocky Mountain. Blocks should be assessed to identify potentially suitable WTR areas. Table 2 provides informaton that should be considered when establishing WTR areas for this species.

As OGMAs are generally larger than WTR areas and are meant to have or obtain old growth features, they may be better suited to the habitat needs of this species.

It is recommended that salvage not occur in WTR areas and OGMAs established to provide habitat for this species. In addition, these areas should be designed to include as many suitable wildlife trees as possible that should be maintained/recruited over the long term (>80 years).

Wildlife habitat area

Goal

Because there are relatively few known nest areas for this species, these sites should be established as WHAs. Suitable habitat should be managed through old forest retention and wildlife tree retention objectives.

Feature

Establish WHAs at known nest sites, occupied breeding territories indicated by detection during the breeding season, or areas with high densities of breeding pairs.

Size

Typically between 10 and 30 ha. Size should be based on estimated home range size using habitat suitability information. High densities may occur within high suitability habitat. Where this occurs, use habitat suitability and home range estimates to determine WHA size.

Design

Design the WHA to minimize disturbance and maintain suitable foraging habitat. The WHA should include a 7–12 ha core area that includes key foraging and security habitats and a ~100 m radius management zone surrounding the core area. The core area should be centred on the nest site when known. The management zone provides adult and fledgling foraging and security habitat. In high density areas, the WHAs may be larger with multiple core areas.

General wildlife measures

Goals

1. Minimize disturbance during the breeding season (1 June to 31 August).
2. Maintain adequate foraging habitat for productivity.
3. Ensure security cover from predators for both foraging adults and fledglings.
4. Ensure WHA is windfirm.

Table 2. Preferred WTP characteristics for the Flammulated Owl

Attribute	Characteristics
Size (ha)	≥4 ha; larger is preferred
Location	PPdh, PPxh, IDFxh, IDFxw, IDFxm, IDFdm, IDFdk, IDFmw
Tree features	visible woodpecker or natural cavities; understorey brush or thickets
Tree species	ponderosa pine; Douglas-fir, possibly trembling aspen or western larch
Tree size (dbh)	64–77 cm; in the absence of trees with the preferred dbh, trees ≥35 cm or largest available should be retained for recruitment
Wildlife tree class	3–7

5. Maintain suitable nesting habitat and surrounding suitable foraging and security habitat (e.g., dry Douglas-fir dominated forests characterized by a mixed-age class, multi-layered canopy, old-growth features, and thickets adjacent to small openings).

Measures

Access

- Do not construct roads. Deactivate or control road access on existing roads.

Harvesting and silviculture

- Do not harvest or salvage within core area except for partial harvesting systems designed to maintain suitable habitat features (i.e., recruitment nest trees; brushy understorey) that will achieve the objective of the general wildlife measures. Treatments should not occur during the breeding season (1 June to 31 August).
- Do not harvest in xeric sites. In the management zone, in mesic or subhygric/hygric sites, use selective harvest methods that retain ≥50% of the dominant or codominant trees of which some should include healthy crowns. Openings should be ≤0.6 ha.
- Retain all ponderosa pine and aspen wildlife trees and all wildlife trees ≥35 cm dbh, using no work zones if necessary.
- Plan for recruitment of ponderosa pine, aspen, and other species into >35 cm dbh class.
- Maintain thickets and veteran trees adjacent to openings.

Pesticides

- Do not use pesticides.

Range

- Manage livestock grazing to retain shrub and grass structure (≥10 cm).

Recreation

- Do not develop trails, roads, or recreation sites within core area.
- Do not cut any wildlife, mature, or veteran trees.

Additional Management Considerations

Post wildlife tree signs to prevent firewood cutting. Avoid isolating quality habitat patches; maintain some mature, veteran, or thicket component as security linkage. Avoid isolating habitat patches by thinning intervening stands (van Woudenberg 1992).

Within xeric or mesic sites where thickets are continuous, particularly on south, east, or west aspect slopes ≥20%, harvest to create openings ≤2 ha. Encourage ponderosa pine regeneration and understorey shrub development.

Information Needs

1. Post-fledgling habitat needs.
2. Further inventories.

Cross References

White-headed Woodpecker

References Cited

Bull, E.L., A.L. Wright, and M.G. Henjum. 1990. Nesting habitat of Flammulated Owls in Oregon. Journ. Raptor Res. 24:52–55.

Campbell, R.W., N.K. Dawe, I. McTaggart-Cowan, J.M. Cooper, G.W. Kaiser, and M.C.E. McNall. 1990. The birds of British Columbia. Vol. II: Nonpasserines. Diurnal birds of prey through woodpeckers. Royal B.C. Mus., Victoria, B.C., and Can. Wildl. Serv., Delta, B.C. 636 p.

Cannings, R.J. 1998. The birds of British Columbia: a taxonomic catalogue. B.C. Min. Environ., Lands and Parks, Victoria, B.C. Wildl. Bull. WB-86.

Cannings, R.J. and B. Booth. 1997. Inventory of Red- and Blue-Listed Species within forest development plan areas: Owls. B.C. Environ., Penticton, B.C. Unpubl. rep.

Christie, D. 1996. Photographic records of foraging adult Flammulated Owls at nests and nesting inventory data (1994–1996). B.C. Min. Environ., Lands and Parks, Operational Inventory Prog., Kamloops, B.C. Unpubl. data.

Christie, D. and D. Low. 1996. Flammulated Owl operational inventory 1996. B.C. Min. Environ., Lands and Parks, Operational Inventory Prog., Kamloops, B.C. Unpubl. data.

Committee on the Status of Endangered Wildlife in Canada (COSEWIC). 2002. Canadian Species at Risk. www.speciesatrisk.gc.ca

Conservation Data Centre (CDC). 1998. Flammulated Owl records reported for British Columbia. B.C. Min. Environ., Lands and Parks, Resour. Inventory Br., Victoria, B.C.

del Hoyo, J., A. Elliott, and J. Sargatal (editors). 1999. Handbook of the birds of the world, Vol. 5. Lynx Edicions, Barcelona, Spain. 759 p.

Harestad, A.S. and D.G. Keisker. 1989. Nest tree use by primary cavity-nesting birds in south central British Columbia. Can. J. Zool. 67:1067–1073.

Hekstra, G.P. 1982. A revision of the American screech-owls (Otus: Strigidae). Ph.D. thesis. Vrije Universiteit te Amsterdam, Amsterdam, Netherlands.

Kamloops Land and Resource Management Planning Team (LRMP). 1995. Kamloops land and resource management plan. Victoria, B.C.

Madsen, S.J. 1985. Habitat use by cavity-nesting birds in the Okanogan National Forest, Washington. M.Sc. thesis. Univ. Wash., Seattle, Wash. 113 p.

McCallum, D.A. 1994a. Flammulated Owl (*Otus flammeolus*). In Birds of North America. No. 93. A. Poole and F. Gill (editors). Acad. Natl. Sci., Philadelphia, Penn., and Am. Ornith. Union, Washington, D.C. 24 p.

_____. 1994b. Review of technical knowledge: Flammulated Owls. In Flammulated, Boreal, and Great gray owls in the United States: a technical conservation assessment. (ed). U.S. Dep. Agric. For. Serv., Rocky Mtn. For. Range Exp. Stn. and Rocky Mtn. Reg., Gen. Tech. Rep. RM-253, pp. 14–46.

McClelland, B.R. and P.T. McClelland. 1999. Pileated Woodpecker nest and roost trees in Montana: links with old-growth and forest "health." Wildl. Soc. Bull. 27:846–857.

NatureServe Explorer. 2002. An online encyclopaedia of life. Version 1.6. NatureServe. Arlington, VA. Available at http://www.natureserve.org/explorer/

Reynolds, R.T. and B.D. Linkhart. 1992. Flammulated Owls in ponderosa pine: Evidence of preference for old growth. U.S. Dep. Agic. For. Serv., Gen. Tech. Rep. RM-213.

Roberts, G. and A. Roberts. 1995. Distribution, habitat selection, and densities of Flammulated Owls (*Otus flammeolus*) in the Cariboo-Chilcotin. B.C. Min. For., Cariboo For. Reg., Williams Lake, B.C. Unpubl. rep.

van Woudenberg, A.M. 1992. Integrated management of Flammulated Owl breeding habitat and timber harvest in British Columbia. M.Sc. thesis. Univ. B.C., Vancouver, B.C.

_____. 1998. Northern Spotted Owl 1998 spring inventory of the Lillooet Forest District. Prep. for B.C. Min. Environ., Lands and Parks, Kamloops, B.C.

_____. 1999. Status of the Flammulated owl in British Columbia. B.C. Min. Environ., Lands and Parks, Wildl. Br., Victoria, B.C. Wildl. Work. Rep. WR-95.

van Woudenberg, A.M. and D.A. Christie. 2000. Flammulated Owl habitat model validation for the Merritt and Kamloops forest districts. *In* Proc. Conf. on the biology and management of species and habitats at risk. L.M. Darling (editor). Kamloops, B.C., Feb. 15–19, 1999. B.C. Min. Environ., Lands and Parks, Victoria, B.C., and Univ. Coll. Cariboo, Kamloops, B.C., pp. 217–222.

van Woudenberg, A.M., D.A. Christie, and D. Erikson. In prep. Flammulated Owl 2000 inventory of the Rocky Mountain Trench. B.C. Min. Environ., Lands and Parks, and Habitat Conserv. Trust Fund, Victoria, B.C.

van Woudenberg, A.M., D.J. Low, and B. Persello. 1995. 1994 extensive survey of Flammulated Owls in the Southern Interior of British Columbia. Report prepared for B.C. Min. Environ., Lands and Parks, Kamloops, B.C.

Waterhouse, M. 1996. Distribution and habitat selection by Flammulated Owls in the Cariboo Forest Region of British Columbia. B.C. Min. For., Cariboo For. Reg., Williams Lake, B.C. Unpubl. data.

_____. 1997. Assessing impacts of management activities on Red-and Blue-listed species in forest-grassland ecotone in the Cariboo Forest Region. B.C. Min. For., Cariboo For. Reg., Williams Lake, B.C. Unpubl. data.

Wiebe, K.L. 2001. Microclimate of tree cavity nests: is it important for reproductive success in Northern Flickers? Auk 118(2):412–421.

Winter, J. 1974. The distribution of the Flammulated Owl in California. West. Birds 5:25–44.

Personal Communications

Holman, P. 2001. Min. Water, Land and Air Protection, Kamloops, B.C.

Waterhouse, M. 1996. Min. Forests, Williams Lake, B.C.

Wright, K. 2001. Wildlife Consultant, West Vancouver, B.C.

GREAT BLUE HERON

Ardea herodias

Original[1] prepared by Ross G. Vennesland

Species Information

Taxonomy

Three subspecies of the Great Blue Heron are recognized in North America, two of which occur in British Columbia: *A. herodias herodias*, which occurs across most of North America, and *A. herodias fannini*, which occurs only on the Pacific coast from Washington to Alaska (Payne 1979; Hancock and Kushlan 1984; Cannings 1998). The separation of these subspecies is based on differences in plumage, morphology, and migratory behaviour (Hancock and Elliott 1978; Payne 1979).

Description

The Great Blue Heron is the largest wading bird in North America, and measures about 60 cm in height, 97–137 cm in length, and 2.1–2.5 kg in mass (Butler 1992). The wings are long and rounded, the bill is long, and the tail is short (Butler 1992). Great Blue Herons fly with deep, slow wingbeats and with their necks folded in an S-shape. Plumage is mostly a blue-grey colour and adults have a white crown.

Distribution

Global

Great Blue Herons breed in three distinct regions of North America. *Ardea herodias occidentalis* breeds in Florida, *A. herodias fannini* breeds on the Pacific coast from Washington to Alaska, and *A. herodias herodias* breeds from southern Canada south to Central America and the Galapagos (Butler 1992). Populations of *A. herodias fannini* are non-migratory (Butler 1992). Winter ranges for *A. herodias herodias* include the Pacific coast of North America, the continental United States, Central America, and northern South America to Colombia, Venezuela, and the Galapagos (Butler 1992).

British Columbia

In British Columbia, *A. herodias fannini* occurs year-round on the Pacific Coast and occasionally inland to the Bulkley Valley (Campbell et al. 1990; Gebauer and Moul 2001), and *A. herodias herodias* occurs in southern interior regions of the province primarily during breeding and migratory periods (Campbell et al. 1990; Cannings 1998). The highest concentrations of breeding herons occur in the Georgia Depression ecoprovince due to the presence of several large colonies (Campbell et al. 1990; Gebauer and Moul 2001).

Forest regions and districts

The *A. herodias fannini* subspecies occurs in the Coast Forest Region and the *A. herodias herodias* subspecies occurs in the Southern and Northern Interior forest regions.

Coast: Campbell River*,[2] Chilliwack*, North Coast*, North Island, Queen Charlotte Islands*, South Island*, Squamish*, Sunshine Coast*

Northern Interior: Kalum, Nadina, Peace, Prince George, Skeena Stikine, Vanderhoof

Southern Interior: 100 Mile House*, Arrow Boundary*, Cascades*, Central Cariboo*, Chilcotin, Columbia*, Headwaters*, Kamloops*, Kootenay Lake*, Okanagan Shuswap*, Quesnel*, Rocky Mountain*

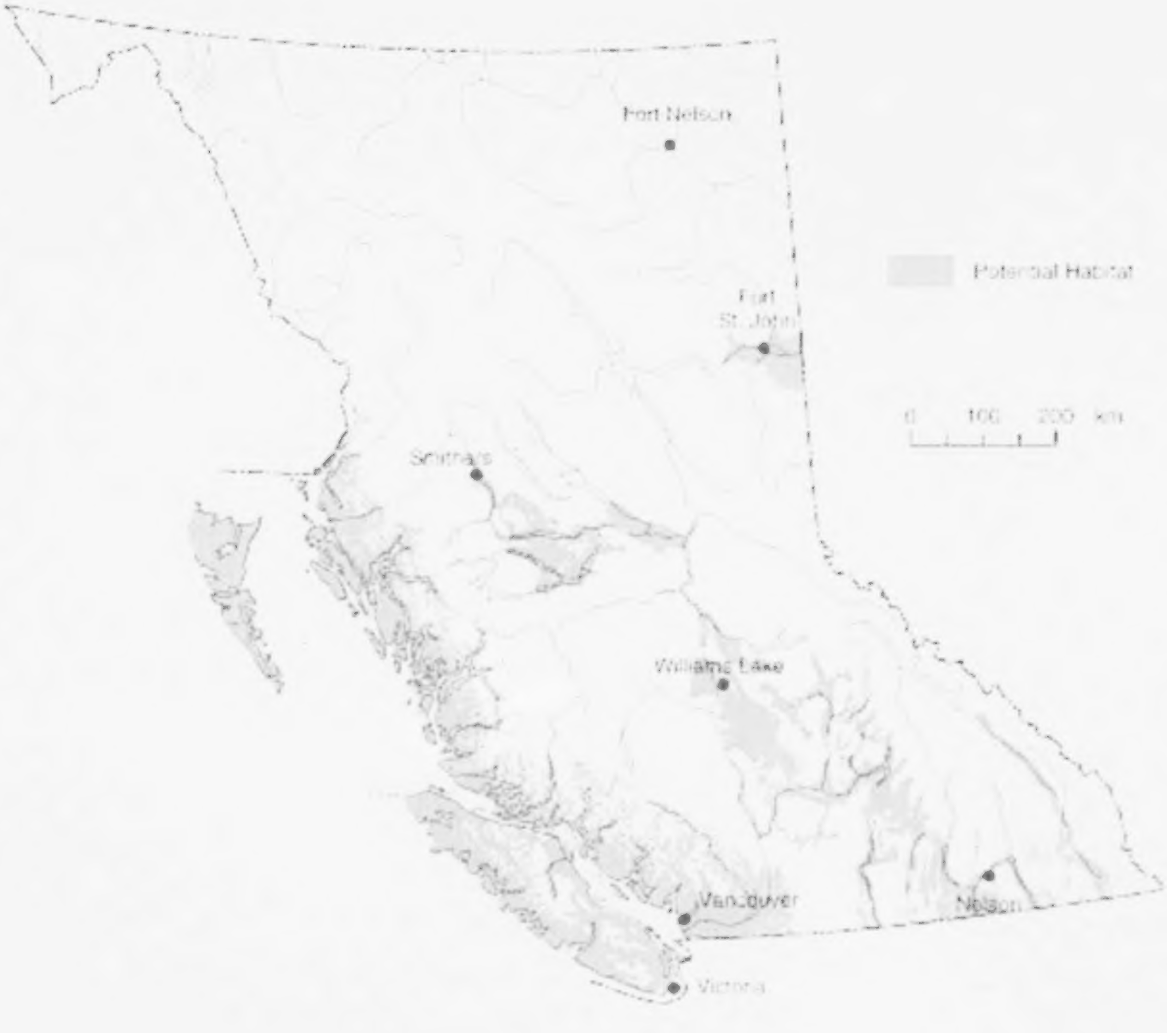
---

[1] Draft Vol. 1 account prepared by Ken Summers.

[2] * = known to breed.

Great Blue Heron

(Ardea herodias)


Fort Nelson
Potential Habitat
Fort St. John
0 100 200 km
Smithers
Williams Lake
Vancouver
Nelson
Victoria

Note: This map represents a broad view of the distribution of potential habitat used by this species. The map is based on several ecosystem classifications (Ecoregion and Biogeoclimatic) as well as current knowledge of the species' habitat preferences. This species may or may not occur in all areas indicated.

Ecoprovinces and ecosections

BOP: PEL, HAP

CEI: BUB, CAB*, CAP*, CHP, FRB, NAU, NEU

COM: CPR, CRU, EPR*, HEL*, KIM, KIR, MEM, NAM, NCF, NIM, NPR, NWC*, NWL, OUF, QCL*, QCT, SBR, SKP*, SPR*, WIM*, WQC*

GED: FRL*, GEL*, LIM*, NAL*, SGI*, SOG*

SBI: BAU, BUB, NEL, NSM, SSM

SIM: BBT, CAM, CCM*, EKT*, EPM, MCR, NPK, SCM*, SFH*, SHH*, SPK*, SPM*, UCV*, UFT

SOI: GUU*, LPR, NIB*, NOB*, NOH*, NTU*, OKR, PAR, SCR, SHB*, SOB*, SOH, STU*, THB, TRU*

Biogeoclimatic units

BG: xh1, xw1

CDF: mm

CWH: dm, ms1, ms2, vh1, vh2, vm1, vm2, wh1, xm

ICH: dw, mk1, mk2, mk3, mw2, mw3, xw

IDF: dk3, dm2, mw1, mw2, un, xh1, xh2

MS: dk

PP: dh2, xh1, xh2

SBS: dk or dh, dw1

Broad ecosystem units

CB, CF, CR, ES, IM, PR, RR, SP, SR, WL, (UR in GED ecoprovince)

Elevation

In British Columbia, most herons occur near sea level on the coast or in the lowlands and valley bottoms of the Interior, though nesting and occurrences have been documented to 1100 m (Campbell et al. 1990).

Life history

Diet and foraging behaviour

Great Blue Herons are prey generalists, although they primarily forage for fish. They stalk prey by walking or standing in shallow water along the shoreline of oceans, marshes, lakes, and rivers and in fields or other vegetated areas (Butler 1992). In upland areas they stalk mostly small mammals such as rodents (Butler 1992). This upland foraging behaviour is more common in winter and for juveniles learning to hunt (Butler 1991). Other prey types include amphibians, reptiles, invertebrates, and birds (Butler 1992). Prey is located by sight and is caught by a rapid thrust of the neck and head (Butler 1992). Herons generally swallow their prey whole (Butler 1992). See Gebauer and Moul (2001) for a more exhaustive review of diet and foraging behaviour.

Reproduction

Great Blue Herons nest throughout the southern Interior and coastal areas of the province, but breeding is concentrated in the Strait of Georgia where several colonies of >100 breeding pairs occur (Eissinger 1996; Butler 1997). It has been estimated that about 84% of the *A. herodias fannini* population and about 65% of all Great Blue Herons in the province breed in this area (Butler 1997; Gebauer and Moul 2001). Large colonies are associated with extensive estuarine mudflats and eelgrass beds around the Fraser River delta (Butler 1993; Eissinger 1996). Colony size has been associated with available foraging area for the Great Blue Heron (Gibbs 1991; Butler 1992; Gibbs and Kinkel 1997).

Breeding is initiated between February and April for *A. herodias fannini* and in late March for *A. herodias herodias* (Butler 1992; Gebauer and Moul 2001). Males arrive at the colony site and establish territories, followed about 1 week later by the females (Butler 1991). Courtship and nest repair and/or building take from several days to about a month (Butler 1991). Monogamous pairs are established for the season (Simpson 1984), and an average of four eggs is laid at about 2-day intervals (Vermeer 1969; Pratt 1970). Clutch size ranges from one to eight, with three to five being typical (Ehrlich et al. 1988; Campbell et al. 1990). Incubation begins soon after the first egg is laid, resulting in asynchronous hatching (Butler 1992). Hatching occurs after about 27 days of incubation (Butler 1992). Young are reared on the nest for about 60 days, fed mostly fish caught near the colony site (Krebs 1974; Simpson 1984). One breeding cycle requires about 100 days, and herons reproduce for about 200 days around the

Strait of Georgia. Thus, herons can potentially breed more than once if their first attempt fails. Breeding duration for the Interior is not known. Heron breeding sites can be relocated rapidly because nests can be built in 3 days (Butler 1997) and eggs can be laid within about 1 week (Butler 1997).

Great Blue Herons first breed after their second winter (Pratt 1973). Estimates of mortality from band recovery data (outside of British Columbia) range from 69% for first year juveniles, 36.3% for second year juveniles, and 21.9%/yr thereafter (Henney 1972, cited by Butler 1992).

Site fidelity

Colonies are dynamic, especially in areas of high disturbance (Butler 1992; Vennesland 2000). Some colonies are used for many years (e.g., Shoal Island, Point Roberts, and Stanley Park, all about 28 years), but most colonies, especially those under 50 nests, are relocated more frequently (Gebauer and Moul 2001). Across British Columbia, it is not clear how frequently the same individuals return to the same nest site. However, at one colony on the Sunshine Coast, Simpson et al. (1987) found that 40% of the breeding herons in 1978 did not return in 1979, and most breeding herons were on different nests and with different mates in 1979. Once a colony has been abandoned for more than 1 year, recolonization occurs infrequently (Gebauer and Moul 2001).

Home range

In British Columbia, breeding colonies range in size from two to about 400 nests with some pairs nesting solitarily (Gebauer and Moul 2001). In south-coastal British Columbia in 1999, Vennesland (2000) reported a mean colony size of 62 nests (SD = 94, *n* = 31), a median of 26 nests, and that the "typical" heron nested in a colony of 199 nests. Large colonies in deciduous trees or small and dispersed colonies can encompass several hectares (R.G. Vennesland, pers. obs.; M. Chutter, pers. comm.). In southern British Columbia, Machmer and Steeger (2002) reported a mean colony size of 19 nests (SE = 6, *n* = 7) and a range of 1–77 nests. During the breeding season, adult herons range within about 30 km of their colonies, although most stay within 10 km (Butler 1991, 1997). During winter, some adults maintain small foraging territories (Butler 1991), but little is known of how frequently alternate sites are used.

Movements and dispersal

Little is known of the initial dispersal of Great Blue Herons from their natal site, but band recoveries suggest that most fledglings disperse from their natal areas (Henney 1972, cited by Butler 1992). Juveniles are believed to disperse widely, often northwards during the summer after fledging. Long distance dispersal of juveniles has been reported. Campbell et al. (1972, cited by Campbell et al. 1990) reported juvenile dispersal from Vancouver to the Fraser Lowlands, Washington State, Oregon State, and Kamloops. On the coast of British Columbia, *A. herodias fannini* is primarily non-migratory, with most birds wintering close to breeding areas (Butler 1997; Gebauer and Moul 2001). In contrast, *A. herodias herodias*, in the interior of the province, is primarily migratory, although the extent of southward movement is unknown. Groups of *A. herodias herodias* are known to overwinter along ice-free watercourses of southern British Columbia (Machmer 2002), but some birds migrate as far south as Mexico and South America (Campbell et al. 1990; Butler 1992).

Habitat

Structural stage (breeding)

5: young forest
6: mature forest
7: old forest

Important habitats and habitat features

Foraging

Great Blue Herons require abundant and accessible prey within 10 km of a breeding location (Butler 1995). Important foraging habitats include aquatic areas such as tidal mudflats, riverbanks, lakeshores, and wetlands (Butler 1992). Shallow water fish species are the most important prey group for herons during breeding and non-breeding seasons (Butler 1992). During winter on the coast, when aquatic prey are less abundant due to a reduced duration of daytime low tides, fallow agricultural fields become important foraging areas for adult and juvenile herons (Butler 1992; Gebauer and Moul 2001). Inland fields are considered an important foraging habitat for both adults and juveniles in the lower Fraser Valley and on southern Vancouver Island (Gebauer and Moul 2001). The number of herons that use non-aquatic foraging habitats is not known, but large numbers of herons reside in south-coastal areas—an estimated 3326 herons (Gebauer and Moul 2001)—so it is likely that these areas are an important foraging habitat for a significant portion of the heron populations in this area. The importance of non-aquatic foraging habitat for herons in the Interior and on other areas of the coast is not known.

Nesting

Colonies occur in relatively contiguous forest, fragmented forest, and solitary trees (Butler 1997). Nests are generally located close together, although highly dispersed colonies have been reported (Vennesland, pers. obs.; M. Chutter, pers. comm.). The most common tree species used for breeding on the coast are red alder (*Alnus rubra*), black cottonwood (*Populus balsamifera*), bigleaf maple (*Acer macrophyllum*), lodgepole pine (*Pinus contorta*), Sitka spruce (*Picea sitchensis*) and Douglas-fir (*Pseudotsuga menziesii*) (Gebauer and Moul 2001). In the southeastern interior, black cottonwood comprises 54% of nest trees with coniferous species—Douglas-fir, western white pine (*Pinus monticola*), hybrid white spruce (*Picea glauca* × *engelmannii*), ponderosa pine (*Pinus ponderosa*), western redcedar (*Thuja plicata*) and western hemlock (*Tsuga heterophylla*)—accounting for the remaining 46% (Machmer and Steeger 2002). Nest in coniferous trees are more difficult to detect, even during aerial surveys. See Gebauer and Moul (2001) for a more exhaustive review of tree species utilized.

The size of Great Blue Heron populations has been correlated with the area of foraging habitat available locally (Butler 1993; Gibbs and Kinkel 1997). It is therefore important, especially in highly urbanized areas such as Vancouver and Kelowna, that sufficient nesting habitat is maintained near important feeding areas (Butler 1997). In addition, since herons frequently relocate colonies, it is also important that alternate forested sites be available. The very large colonies (~200–400 breeding pairs) that occur around the lower Fraser Valley rely on large parcels of primarily deciduous (mostly red alder) forest. Eagle activity is likely increasing at these sites, making the availability of this type of forest important for reducing the potential impact of foraging eagles by giving herons alternate nesting locations if eagle activity becomes too high at traditional sites (Vennesland 2000).

Conservation and Management

Status

Both subspecies of the Great Blue Heron are on the provincial *Blue List* in British Columbia. In Canada, the *fannini* subspecies is considered a species of *Special Concern* (COSEWIC 2002). The status of the *herodias* subspecies has not been assessed.

Summary of ABI status in BC and adjacent jurisdictions (NatureServe Explorer 2002)

Subspecies	BC	AB	AK	ID	MT	OR	WA	Canada	Global
A. h. fannini	S3B, S5N	–	S4	–	–	–	?	N?	G5T4
A. h. herodias	S3B, S5N	S3B, S1N	–	S5B, S5N	S4B, SZN	S4	S4S5	N5B, NZN	G5T5

Trends

Population trends

Population size has been difficult to estimate for this species because colonies are not stable entities and are difficult to track in a standardized fashion (Butler 1997; Vennesland 2000; Gebauer and Moul 2001). The *fannini* subspecies in British Columbia is currently estimated at 3626 breeding adults, with an estimated 3326 adults breeding in the Strait of Georgia and 300 breeding elsewhere on the coast (Butler 1997; Gebauer and Moul 2001). The size of the *herodias* subspecies in British Columbia is not known, but probably ranges between 300 and 700 individuals (Gebauer and Moul 2001).

Population trends are also difficult to estimate. Few data are available on the coast prior to the past 30 years; however, over this period the population has been reported to be generally stable or declining. Gebauer and Moul (2001) reported that the Great Blue Heron population on the coast had apparently not changed significantly since Butler (1997) estimated the heron population from data collected from 1987 to 1992, although some measures showed declines (Gebauer and Moul 2001). An annual decline rate of 5.7% was reported from Breeding Bird Survey (BBS) data from 1966 to 1994 (Downes and Collins 1996), but Christmas Bird Counts (CBC) showed populations to be generally stable (Gebauer and Moul 2001). An exception is the Sunshine Coast area, where CBC data indicate a decline from 1991 to 1997. In addition, the number of herons observed breeding on the Sunshine Coast dropped from 97 in 1978 (Forbes et al. 1985b) to 11 in 1999 (Vennesland 2000). Campbell et al. (2001) concluded that coastal Great Blue Herons were the most at risk out of 28 species of birds in British Columbia that showed significant declines based on BBS data. It is generally believed that the size of the Great Blue Heron population in the Interior has increased over the past century, but little information is available on the magnitude of this increase (Gebauer and Moul 2001). Seventeen active breeding sites with 259 active heron nests were detected during a 2002 breeding inventory of the Columbia Basin in British Columbia (Machmer and Steeger 2002). This compares to 10 active sites with 266 active nests in a 1982 survey of a smaller portion of the basin (Forbes et al. 1985a); differences in survey methods and survey area size limit conclusions regarding population trends.

Habitat trends

Suitable nesting habitat has undoubtedly declined in British Columbia over the past century due to increases in the size of human populations and industry, especially in south-coastal areas around the Fraser River delta and Vancouver Island (Moore 1990; Butler 1997; Campbell et al. 2001). The availability of suitable forested lands in British Columbia continues to decrease (Butler 1997; Gebauer and Moul 2001). Habitat destruction in south coastal British Columbia has resulted in the abandonment of at least three colonies (Gebauer 1995; Vennesland 2000). Similarly, the construction of dams, flooding or reservoirs, and the development of forest and riparian lands is associated with some heron colony abandonment in the Interior (Machmer and Steeger 2002).

Suitable foraging habitat is also likely declining in British Columbia, and this decline is considered to be as or more important than that of breeding habitat (Gebauer and Moul 2001). The size of Great Blue Heron populations is correlated with the area of foraging habitat available locally, and consequently the largest concentrations of herons occur around the Fraser River delta where extensive mudflats and eelgrass beds provide abundant foraging locations (Butler 1993; Eissinger 1996; Gibbs and Kinkel 1997). Local declines in foraging habitat have likely been greatest in south-coastal British Columbia because most of the province's human population is located in this area (Butler 1997; Gebauer and Moul 2001).

Threats

Population threats

Direct threats to Great Blue Heron populations in British Columbia include disturbance and mortality from predators and humans, food supply limitations, contamination, and weather.

Vennesland (2000) reported that Bald Eagle (*Haliaeetos leucocephalus*) depredation and human disturbance were the most important direct threats to heron populations because of reductions in breeding productivity. During the 1998 and 1999 breeding seasons, eagles were likely involved in 13 of 14 colony abandonments observed, and eagle depredation of eggs and nestlings had a significant negative impact on the breeding productivity of colonies in south coastal British Columbia (Vennesland 2000). Over the same period, human disturbance was likely involved in one colony abandonment (Vennesland 2000). Other authors have also commented on the potential problems associated with eagles and humans (e.g., Parnell et al. 1988; Norman et al. 1989; Butler et al. 1995; Butler and Vennesland 2000; Gebauer and Moul 2001). Human disturbance has been implicated in many historical colony abandonments in British Columbia (Kelsall and Simpson 1979; Forbes et al. 1985a). Additionally, both these sources of disturbance are increasing in British Columbia (Vermeer et al. 1989; Blood and Anweiller 1994), and their impact on breeding herons is also probably increasing (Vennesland 2000). The killing of adult herons who feed on farmed fish stocks is currently prohibited due to the large influence that the removal of breeding adults can have on local heron populations (Butler and Baudin 2000; R.W. Butler, pers. comm.), although the regional manager of Environmental Stewardship, in consultation with the Canadian Wildlife Service, can issue a permit to kill herons at fish farms. Eagles also attack and kill adult herons (Forbes 1987; Sprague et al. 2002). In addition, although herons commonly nest in urban areas (Butler 1997; Vennesland 2000), disturbance from humans can cause herons to temporarily abandon their breeding attempts, allowing predators to take eggs (Moul 1990). High levels of human activity near breeding colonies have also been linked with increased disturbance from eagles (Vennesland 2000). There have been no reports of direct negative effects on breeding or non-breeding herons from cattle or other agricultural animals. Grazing could potentially alter heron foraging success if changes in vegetative cover made it more difficult to catch prey, but no data are available that address this question.

Food supply problems can also threaten Great Blue Heron populations. Pratt (1972) and Blus and Henney (1981) reported significant overwinter mortality of herons on the Pacific coast of the United States due to starvation. In addition, Butler (1995) found that starvation due to a lack of foraging skill was the most important factor affecting juvenile survival during the first winter after fledging. Food supply problems can also affect heron breeding productivity if adult herons cannot obtain enough food to adequately feed their young (Gebauer and Moul 2001). However, food limitations are currently viewed as a less important threat than disturbance from predators and humans (Butler 1997; Vennesland 2000).

Contamination from human industrial activities likely caused the abandonment of one colony near Vancouver Island in the late 1980s (Elliott et al. 1989), but this threat is declining in British Columbia and is currently not seen as a widespread problem (Elliott et al. 2003).

Adverse weather can also impact heron populations. Forbes et al. (1985b) suggested that low rainfall and/or extensive sunshine could increase breeding productivity, implying that high rainfall and limited sunshine might reduce productivity. This effect could be due to hypothermia in nestlings, or reduced prey delivery from attending adults (Gebauer and Moul 2001). Tree or nest blowdown has also been implicated in the death of nestlings (Burkholder and Smith 1991).

Habitat threats

Threats to Great Blue Heron habitat in British Columbia include the loss of breeding and foraging areas to urban development, forestry, hydroelectric power development, and natural processes. Urban development and forestry are the main causes of habitat loss. Heron populations in British Columbia are concentrated around the Georgia Depression ecoprovince and in valley bottoms of the Interior, and these two habitats are also the primary centres of human activity in the province (Moore 1990; Butler 1997; Campbell et al. 2001). Forestry can impact heron habitat through the removal of active or potential nest trees (Bjorkland 1975; Werschkul et al. 1976; Gebauer and Moul 2001). Habitat is also threatened by weather-related problems such as tree or nest blowdown (see previous section). Forest fragmentation may increase access to, or visibility of, breeding colonies for predators, such as Bald Eagles, thereby reducing the amount of suitable breeding habitat available to herons (Vennesland 2000).

Legal Protection and Habitat Conservation

The Great Blue Heron, its nests and eggs are protected year-round from direct persecution by the provincial *Wildlife Act*, as well as the *Migratory Birds Convention Act*. Scare/kill permits were provided up to 1998 to control herons feeding on fish stocks, but these have since been revoked (Butler and Baudin 2000).

Many sites are currently protected within regional or municipal parks, wildlife management areas, or have other protected status directly related to the occupancy of breeding herons (Gebauer and Moul 2001). This includes colonies at Vaseux Lake and Wilmer Wildlife Area in the Kootenay region, as well as the four largest colonies in the lower Fraser Valley (67% of all active nests in the area, $n = 1070$) and two colonies on Vancouver Island and the Gulf Islands (39% of all active nests in the area, $n = 459$) (Gebauer and Moul 2001). In total, 59% of all active nests in the Georgia Depression are currently protected ($n = 1529$ active nests). The continuing efforts of the Wild Bird Trust are now directed at mid-sized colonies to secure covenants on private and commercial lands (Butler and Baudin 2000; Gebauer and Moul 2001). The Delta Farmland Trust has recently established grassland set-asides to protect heron foraging habitat, and several projects have been undertaken to restore original habitat in areas that have been altered by causeways and dikes (Gebauer and Moul 2001).

Under the results based code, some critical foraging and nesting habitats could be addressed through establishment of old growth management areas, riparian management areas and wildlife tree retention areas. In addition, the "wildlife habitat feature" designation may also protect known nest sites. Although buffers are not currently enabled under this designation, licensees should voluntarily maintain a buffer to minimize disturbance and maintain the integrity of nesting habitat. However, many breeding colonies are located on private land, and the protection of heron nesting locations on Crown land should be considered a priority because most herons nest on private land where less regulatory control is available.

For colonies on private land, best management practices guidelines have been created by the British Columbia Ministry of Water, Land and Air Protection, Region 1 (Vancouver Island). These voluntary guidelines outline how developers can help to protect breeding herons in existing developed areas (K. Morrison, pers. comm.). In addition, herons on private land can be protected through zoning at the municipal level (M. Henigman, pers. comm.).

Identified Wildlife Provisions

Wildlife habitat area

Goals

Protect heron nesting sites and adjacent foraging areas from human disturbance and habitat loss or alteration.

Feature

Establish WHAs at nesting areas and nesting colonies. Important foraging sites (i.e., concentrations of herons feeding on a regular basis) may be recommended for WHA establishment by the Canada/U.S. Heron Working Group.

Size

Typically 80 ha but will ultimately depend on site-specific factors. Size should depend on the number of individuals using locations for breeding and/or foraging (Butler 1997; Gebauer and Moul 2001) and density of use. Other important factors to be considered include location, topography, proximity of foraging sites (for colonies), relative isolation, and degree of habituation to disturbance.

Design

The design of the WHA should consider the colony size, location, proximity of foraging sites, relative isolation, and degree of habituation to disturbance. The core area should be approximately 12 ha and include known nest sites, potential nesting areas and, where appropriate, foraging areas and flight paths. Ideally, the boundary of the core area should be approximately 200 m radius from the edge of the colony or important habitat feature(s). A 300 m management zone should also be included to minimize disturbance to all components of the WHA (nest site, foraging sites).

In areas where human disturbance is a concern, incorporate boundaries that may act as barriers to humans wherever possible. Carlson and McLean (1996) showed that barriers that completely excluded humans were more effective than management zones that allowed some intrusion, and breeding productivity was higher at sites with stronger barriers (e.g., ditches and fences).

For existing developed sites in areas of high human use, a minimum naturally vegetated strip around all breeding colonies of at least 50 m is recommended by the best management practices guidelines produced by the Ministry of Water, Land and Air Protection in Region 1 (K. Morrison, pers. comm.).

General wildlife measures

Goals

1. Minimize disturbance during the breeding season (15 February to 31 August) and between 1 November and 31 March for colonies that occupy areas year round.
2. Maintain important structural elements for nesting and foraging (i.e., suitable nest trees, non-fragmented forest around nest trees, wetland characteristics for foraging if applicable, roost trees, and ground barriers to exclude mammalian predators).

Measures

Access

- Do not develop roads or trails within the core area. Road and trail construction or blasting in the management zone should not occur between 15 February and 31 August.
- Limit access on existing roads and trails between 15 February and 31 August. Types and levels of use must not exceed levels that customarily occur during the breeding period.

Harvesting and silviculture

- Do not harvest within the core area.
- Do not harvest within the management zone between 15 February and 31 August.
- No silvicultural activities, except restoration or enhancement activities, should occur within the core area. In the management zone, no mechanized activities that exceed noise or disturbance levels (including distance from colony) previously experienced during this period should occur between 15 February and 31 August.
- Within a management zone that has few trees other than the nest trees, restocking and/or silvicultural techniques can be applied to enhance rapid development and protection of the stand.

Pesticides

- Do not use pesticides.

Range

- Maintain WHA in a properly functioning condition.
- Control level of livestock use and plan grazing to ensure that the structural integrity of stands of emergent vegetation are maintained. Fencing could be required by the statutory decision maker to meet goals described above.

Recreation

- Do not develop recreation trails, structures, or facilities.

Additional Management Considerations

Avoid disturbance within 500 m of colonies and adjacent foraging habitats between 15 February and 31 August and between 1 November and 31 March for year-round colonies. Some colonies may have become habituated to some levels of disturbance, in which case it may not be necessary to refrain from activities. In general, motorized, loud, or continuous activities are more disturbing than non-motorized activities. When incorporating barriers to minimize access or disturbance, it is better to use barriers that completely exclude humans than those that allow some intrusion (Carlson and McLean 1996).

Where permanent activities or habitat modifications are planned, vegetative screening should be planted or maintained between the activity and the colony as close to the activity area as possible. Where possible, the trees/shrubs planted should be a mixture of deciduous and coniferous, and half should be of the same species currently used for nesting.

Consider constructing a fence or other barrier between the activity and vegetative screening.

Protect heron foraging resources, especially those within 4 km of colonies and in key wintering areas, from development, degradation, and pollution, particularly aquaculture operations and discharge of toxic effluents. Coastal heron concentrations occur on estuaries and other low gradient intertidal habitats and on adjacent farmlands during the winter. Interior birds feed in marshes and along shallow shorelines of lakes and rivers; during winter they need areas of open (unfrozen) water.

Maintain perch trees adjacent to major summer and winter foraging areas.

Prevent further loss of important coastal and interior riparian mature/old-growth forest nesting habitat to urban/suburban and forest development.

Information Needs

1. Monitoring of key breeding locations is ongoing on the coast and should be continued at the existing, or a more intensive level.
2. Heron surveys on foraging grounds.
3. Current and future impact of Bald Eagle disturbance at coastal and interior heron colonies. Eagle populations are increasing, but it is not known how long they will continue to do so, whether human activities are enhancing their populations, or how this activity may change the location or distribution of breeding herons.

Cross References

Marbled Murrelet, "Queen Charlotte" Goshawk, Spotted Owl, "Vancouver Island" Northern Pygmy-Owl

References Cited

Bjorkland, R.G. 1975. On the death of a midwestern heronry. Wilson Bull. 87:284–287.

Blood, D.A. and G.G. Anweiller. 1994. Status of the Bald Eagle in British Columbia. B.C. Min. Environ., Lands and Parks, Wildl. Br., Victoria, B.C. Wildl. Work. Rep. WR-62.

Blus, L.J. and C.J. Henney. 1981. Suspected Great Blue Heron decline after a severe winter in the Columbia Basin. Murrelet 62:16–18.

Burkholder, G. and D.G. Smith. 1991. Nest trees and productivity of Great Blue Herons (*Ardea herodias*) at Knox Lake, north-central Ohio. Colonial Waterbirds 14:61–62.

Butler, R.W. 1991. Habitat selection and time of breeding in the Great Blue Heron (*Ardea herodias*). Ph.D. dissertation. Univ. B.C., Vancouver, B.C.

_____. 1992. Great Blue Heron. *In* The birds of North America No. 25. A. Poole, P. Stettenheim, and F. Gill (editors). Philadelphia: Acad. Nat. Sci., Philadelphi, Penn., and Am. Ornith. Union, Washington, D.C.

_____. 1993. Time of breeding in relation to food availability of female Great Blue Herons (*Ardea herodias*). Auk 110:693–701.

_____. 1995. The patient predator: population and foraging ecology of the Great Blue Heron (*Ardea herodias*) in British Columbia. Can. Wildl. Serv., Ottawa, Ont. Occas. Pap. 83.

_____. 1997. The Great Blue Heron. UBC Press, Vancouver, B.C.

Butler, R.W. and P. Baudin. 2000. Status and conservation stewardship of the Pacific Great Blue Heron in Canada. *In* Proc. Conf. on the biology and management of species and habitats at risk. L.M. Darling (editor). Kamloops, B.C., Feb. 15–19, 1999. B.C. Min. Environ., Lands and Parks, Victoria, B.C., and Univ. Coll. Cariboo, Kamloops, B.C., pp. 247–250.

Butler, R.W. and R.G. Vennesland. 2000. Commentary: integrating climate change and predation risk with wading bird conservation research in North America. Waterbirds 23:535–540.

Butler, R.W., P.E. Whitehead, A.M. Breault, and I.E. Moul. 1995. Colony effects of fledging success of Great Blue Herons (*Ardea herodias*) in British Columbia. Colonial Waterbirds 18:159–165.

Campbell, R.W., N.K. Dawe, I. McTaggart-Cowan, J.M. Cooper, G.W. Kaiser, and M.C.E. McNall. 1990. The birds of British Columbia. Vol. 1. Nonpasserines: Loons through waterfowl. Royal B.C. Mus., Victoria, B.C., and Can. Wildl. Serv., Delta, B.C. 535 p.

Campbell, R.W., N.K. Dawe, I. McTaggart-Cowan, J.M. Cooper, G.W. Kaiser, A.C. Stewart, and M.C.E. McNall. 2001. The birds of British Columbia. Vol. IV: Passerines. Wood Warblers through Old World Sparrows. Royal B.C. Mus., Victoria, B.C., and Can. Wildl. Serv., Delta, B.C.

Cannings, R.J. 1998. The birds of British Columbia: a taxonomic catalogue. B.C. Min. Environ., Lands and Parks, Wildl. Br., Victoria, B.C. Wildl. Bull. B-86. 252 p.

Committee on the Status of Endangered Wildlife in Canada (COSEWIC). 2002. Canadian Species at Risk. www.speciesatrisk.gc.ca

Downes, C. and B. Collins. 1996. The Canadian breeding bird survey, 1966–1994. Can. Wildl. Serv., Ottawa, Ont. Program Notes 105.

Ehrlich, P.R., D.S. Dobkin, and D. Wheye. 1988. The birder's handbook: a guide to the natural history of North American birds. Simon and Shuster, New York, N.Y. 785 p.

Eissinger, A. 1996. Great Blue Herons of the Salish Sea: a model plan for the conservation and stewardship of coastal herons colonies. Report prepared for Trillium Corporation, ARCO Products, and Wash. Dep. Fish Wildl., Olympia, Wash.

Elliott, J.E., R.W. Butler, R.J. Norstrom, and P.E. Whitehead. 1989. Environmental contaminants and reproductive success of Great Blue Herons, *Ardea herodias*, in British Columbia, 1986–87. Environ. Poll. 59:91–114.

Elliott, J.E., M.L. Harris, L.K. Wilson, P.E. Whitehead, and R.J. Norstrom. 2003. Reproductive success and chlorinated hydrocarbon contamination of resident Great Blue Herons (*Ardea herodias*) from coastal British Columbia, Canada, 1977–2000. Environ. Pollution 121:207–227.

Forbes, L.S. 1987. Predation on adult Great Blue Herons: Is it important? Colonial Waterbirds 10:120–122.

Forbes, L.S., K. Simpson, J.P. Kelsall, and D.R. Flook. 1985a. Great Blue Heron colonies in British Columbia. Can. Wildl. Serv., Delta, B.C. Unpubl. rep.

_____. 1985b. Reproductive success of Great Blue Herons in British Columbia. Can. J. Zool. 63:1110–1113.

Gebauer, M.B. 1995. Status and productivity of Great Blue Heron (*Ardea herodias*) colonies in the lower Fraser River Valley in 1992, 1993 and 1994. B.C. Min. Environ., Lands and Parks, Surrey, B.C. 105 p.

Gebauer, M.B. and I.E. Moul. 2001. Status of the Great Blue Heron in British Columbia. B.C. Min. Environ., Lands and Parks, Wildl. Br., Victoria, B.C. Wildl. Work. Rep. 102.

Gibbs, J.P. 1991. Spatial relationships between nesting colonies and foraging areas of Great Blue Herons. Auk 108:764–770.

Gibbs, J.P. and L.K. Kinkel. 1997. Determinants of the size and location of Great Blue Heron colonies. Colonial Waterbirds 20:1–7.

Hancock, J. and H. Elliott. 1978. The herons of the world. London Editions, London, U.K.

Hancock, J. and J. Kushlan. 1984. The herons handbook. Harper and Row, New York, N.Y.

Henney, C.J. 1972. An analysis of the population dynamics of selected avian species with special reference to changes during the modern pesticide era. U.S. Fish and Wildl. Serv., Wahsington, D.C. Wildl. Res. Rep. I.

Kelsall, J.P. and K. Simpson. 1979. A three-year study of the Great Blue Heron in southwestern British Columbia. Proc. Colonial Waterbird Group 3:69–74.

Krebs, J.R. 1974. Colonial nesting and social feeding as strategies for exploiting food resources in the Great Blue Heron (*Ardea herodias*). Behaviour 51:99–131.

Machmer, M.M. 2002. Evaluation of fall and winter use of Waldie Island by Great Blue Herons in B.C. Hydro and Power Authority, Burnaby, B.C.

Machmer, M.M. and C. Steeger. 2002 (draft). Breeding inventory and habitat assessment of Great Blue Herons in the Columbia River Basin. Columbia Basin Fish and Wildl. Compens. Prog. Nelson, B.C.

Moore, K. 1990. Urbanization in the Lower Fraser Valley, 1980–1987. Can. Wildl. Serv., Delta, B.C. Tech. Rep. 120.

Moul, I.E. 1990. Environmental contaminants and breeding failure at a Great Blue Heron colony on Vancouver Island. M.Sc. thesis. Univ. B.C., Vancouver, B.C.

NatureServe Explorer. 2002. An online encyclopaedia of life. Version 1.6. NatureServe. Arlington, VA. Available at http://www.natureserve.org/explorer/

Norman, D.M., A.M. Breault, and I.E. Moul. 1989. Bald Eagle incursions and predation at Great Blue Heron Colonies. Colonial Waterbirds 12:215–217.

Parker, J. 1980. Great Blue Herons (*Ardea herodias*) in north-western Montana: nesting habitat use and the effects of human disturbance. M.Sc. thesis. Univ. Montana.

Parnell, J.F., D.G. Ainley, H. Blokpoel, B. Cain, T.W. Custer, J.L. Dusi, S. Kress, J.A. Kushlan, W.E. Southern, L.E. Stenzel, and B.C. Thompson. 1988. Colonial waterbird management in North America. Colonial Waterbirds 11:129–345.

Payne, R.B. 1979. Ardeidae. In Checklist of birds of the world. E.M. a. G.W.C. (editors). Mus. Comp. Zool., Cambridge, Mass., pp. 193–244.

Pratt, H.M. 1970. Breeding biology of Great Blue Herons and Common Egrets in Central California. Condor 72:407–416.

______. 1972. Nesting success of common egrets and Great Blue Herons in the San Francisco Bay Region. Condor 74:447–453.

______. 1973. Breeding attempts by juvenile Great Blue Herons. Auk 90:897–899.

Quinn, T. and R. Milner. 1999. The Great Blue Heron: management recommendations for Washington's priority species. Vol. IV: Birds. Wash. State Dep. Fish Wildl. Available from http://www.wa.gov/wdfw/hab/phsrecs.htm.

Simpson, K. 1984. Factors affecting reproduction in Great Blue Herons (*Ardea herodius*). M.Sc. thesis, Univ. B.C., Vancouver, B.C. Unpubl.

Simpson, K. and J.P. Kelsall. 1978. Capture and banding of adult Great Blue Herons at Pender Harbour, British Columbia. Proc. Colonial Waterbird Group 1978:71–78.

Simpson, K., J.N.M. Smith, and J.P. Kelsall. 1987. Correlates and consequences of coloniality in Great Blue Herons. Can. J. Zool. 65:572–577.

Vennesland, R.G. 2000. The effects of disturbance from humans and predators on the breeding decisions and productivity of the Great Blue Heron in south-coastal British Columbia. M.Sc. thesis. Simon Fraser Univ., Burnaby, B.C.

Vermeer, K. 1969. Great Blue Heron Colonies in Alberta. Can. Field-Nat. 83:237–242.

Vermeer, K., K.H. Morgan, R.W. Butler and G.E.J. Smith. 1989. Population, nesting habitat and food of Bald Eagles in the Gulf Islands. *In* The status and ecology of marine and shoreline birds in the Strait of Georgia, British Columbia. K. Vermeer and R.W. Butler (editors). Can. Wildl. Serv., Ottawa, Ont. Spec. Publ., pp. 123–131.

Vos, K.K., R.A. Ryder, and W.D. Graul. 1985. Response of breeding Great Blue Herons to human disturbance in North-central Colorado. Colonial Waterbirds 8:13–22.

Werschkul, D.F., E. McMahon, and M. Leitschuh. 1976. Some effects of human activities on the Great Blue Heron in Oregon. Wilson Bull. 88:660–662.

Personal Communications

Butler, R.W. 2001. Canadian Wildlife Service, Delta, B.C.

Chutter, M. 2002. Min. Water, Land and Air Protection, Victoria, B.C.

Henigman, M. 2002. Min. Water, Land and Air Protection, Nanaimo, B.C.

Morrison, K. 2002. Min. Water, Land and Air Protection, Nanaimo, B.C.

“INTERIOR” WESTERN SCREECH-OWL

Otus kennicottii macfarlanei

Original prepared by R.J. Cannings

Species Information

Taxonomy

The Western Screech-Owl was first described in 1867, but was long considered conspecific with the Eastern Screech-Owl, *Otus asio* (e.g., AOU 1957). One hundred years later, Marshall (1967) recognized four incipient species within this larger taxon: *O. asio*, *O. kennicottii*, *O. seductus*, and *O. cooperi*. This separation was formalized by AOU (1983) by resurrecting *O. kennicottii* and giving it the English name Western Screech-Owl. Indeed, AOU (1983, 1998) and König et al. (2000) now consider all four of Marshall's incipient species as allospecies of a superspecies.

Fifteen subspecies were recognized by Peters (1940) and 13 by AOU (1957). In the next major revision, Marshall (1967) considered much of the geographic variation in Western Screech-Owls to be clinal, and further reduced the number of subspecies to eight. Hekstra (1982a, 1982b), on the other hand, recognized 18 subspecies. In a recent revision based largely on morphometrics, Gehlbach (2003) retains eight subspecies, only slightly different from Marshall's treatment. Subspecies that range into British Columbia are:

- *O. kennicottii kennicottii*, along entire coast including the Gulf Islands and Vancouver Island.
- *O. kennicottii macfarlanei*, southern Interior, and west Kootenays.

Description

The Western Screech-Owl is a small owl (150–250 g) with noticeable feather tufts on the corners of its head. Generally cryptically coloured; breast and belly are pale with dark streaks, back is brownish (coast) or brownish-grey (interior) with fine dark streaks. *O. kennicottii kennicottii* is generally a large subspecies with brown base colour to its plumage, while *O. kennicottii* macfarlanei is greyer in colour and even larger in size.

Distribution

Global

Resident along the Pacific coast from southern Alaska south to Baja California, and in the interior areas of western North America from southern British Columbia south through western Montana, western Colorado, and western Texas south to central Mexico. The Interior Western Screech-Owl occurs east of the Cascade Mountains from southern British Columbia, south to Washington, Oregon, Idaho, and Montana.

British Columbia

The Interior Western Screech-Owl occurs in the Okanagan Valley. There are scattered records elsewhere in the southern Interior but no evidence of breeding. It probably breeds, at least irregularly, in the Thompson Valley between Chase and Spences Bridge. Breeding has recently been confirmed in the West Kootenays near Castlegar and Creston.

Forest region and districts

Southern Interior: Arrow Boundary, Cascades, Kamloops, Kootenay Lake, Okanagan Shuswap

Ecoprovince and ecosections

SIM: EKT, SCM, SFH, SHH, SPM

SOI: GUU, NIB, NOB, NOH, NTU, OKR, SHB, SOB, SOH, irregular in STU, THB, TRU

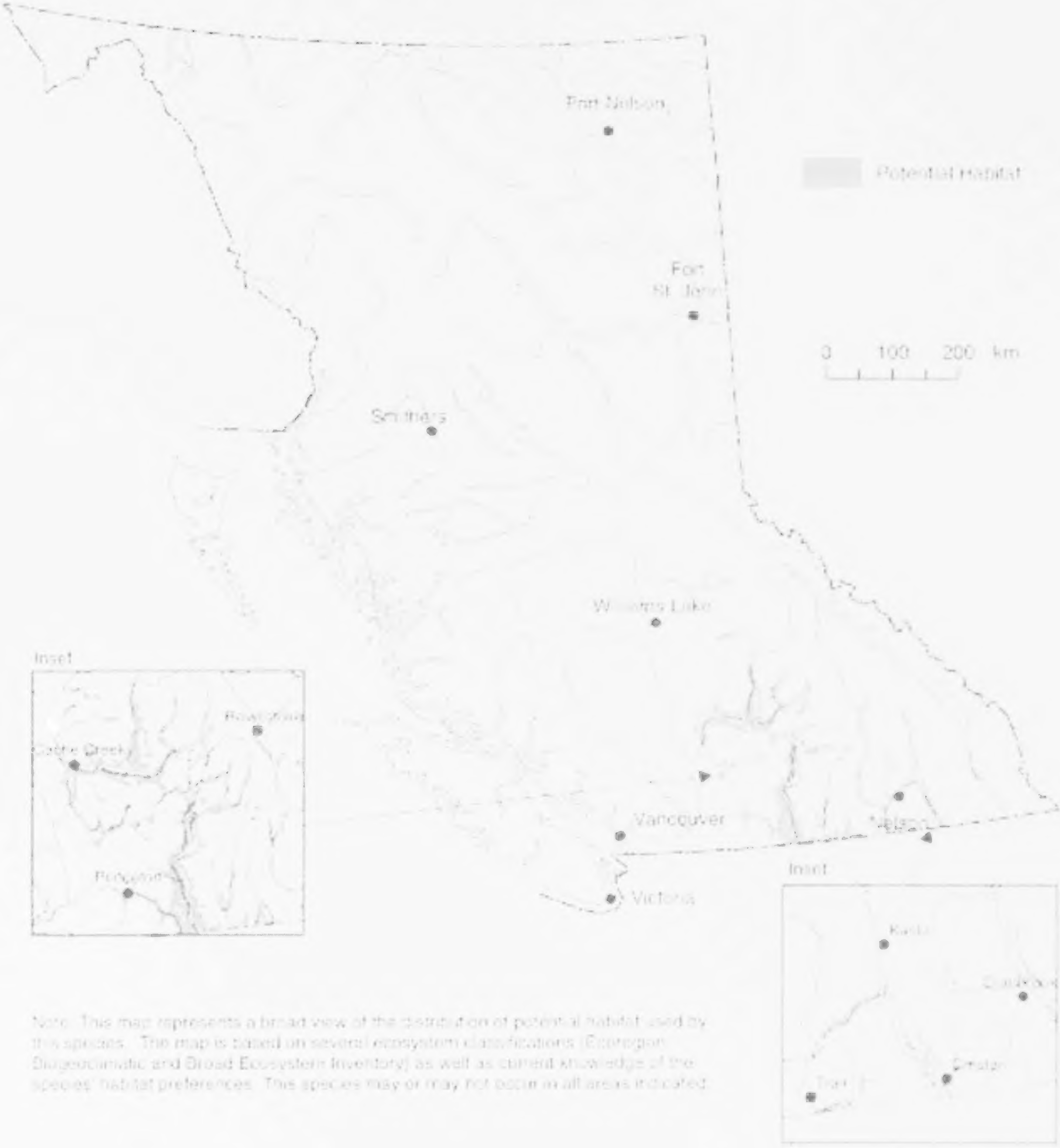
Biogeoclimatic units

BG: xh1, irregular in xh2, xw, xw1

PP: dh1, dh2, xh1, xh2

Western Screech-Owl - subspecies *macfarlanei*

(Otus kennicottii macfarlanei)


Fort Nelson
Potential Habitat
Fort St. John
0 100 200 km
Smithers
Williams Lake
Inset
Cache Creek
Princeton
Vancouver
Nelson
Victoria
Inset
Kaslo
Cranbrook
Creston
Trail

Note: This map represents a broad view of the distribution of potential habitat used by this species. The map is based on several ecosystem classifications (Ecoregion, Biogeoclimatic and Broad Ecosystem Inventory) as well as current knowledge of the species' habitat preferences. This species may or may not occur in all areas indicated.

IDF: dk1, dk2, dk3, dm1, mw1, mw2, xh1, xh1a, irregular in xh2, xw

ICH: dw, mw2, irregular in xw

Broad ecosystem units

CR, DF, DP, IG, PP, RR, SP, WL, WR

Elevation

0–700 m

Life History

Diet and foraging behaviour

The Western Screech-Owl is a generalist predator on small animals, including mice, shrews, birds, insects, frogs, salamanders, crayfish, fish, and earthworms (Cannings and Angell 2001).

Reproduction

Western Screech-Owls nest in tree cavities, including those excavated by Pileated Woodpeckers (*Dryocopus pileatus*) and Northern Flickers (*Colaptes auratus*); they also readily use nest-boxes. British Columbia nests ranged from 1.2 to 12.2 m above ground; all nests reported were in trees >25 cm dbh ($n = 43$; Campbell et al. 1990). There is a strict division of labour; males provide all the food for females and young while the females incubate the eggs and brood the young. Clutch size is two to seven eggs, usually three to five (Cannings and Angell 2001). Egg dates in British Columbia range from 17 March to 31 May ($n = 49$), most (53%) 9–21 April; dates for young in nests range from 19 April to 21 August ($n = 53$), with 51% from 8 May to 3 June (Campbell et al. 1990).

Site fidelity

Pairs are resident throughout the year on nesting territories (Cannings and Angell 2001).

Home range

Home range sizes can be very small in optimal habitat, but a reasonable estimate for home range size in British Columbia would be about 2.5–10 ha (Cannings and Angell 2001).

Dispersal and movements

The Western Screech-Owl is non-migratory; young birds disperse in late summer and fall to establish new territories. Both male and female young disperse from the natal area, but on average females travel about three times as far as males (about 15 km vs. 5 km) in the first 3 months of dispersal (Ellsworth and Belthoff 1997).

Habitat

Structural stage

6: mature forest
7: old forest

Important habitats and habitat features

Nesting

Breeding territories are closely associated with riparian habitats, particularly those dominated by black cottonwood (*Populus trichocarpa*), trembling aspen (*Populus tremuloides*), and water birch (*Betula occidentalis*) (Cannings 1997). Since cavities are needed for both nesting and roosting, a breeding territory must contain at least two suitable cavities to be useful to a pair of screech-owls. Nest trees may be in decay class 2 through 6.

Nesting and roosting sites are in tree cavities, usually those made by Northern Flickers or Pileated Woodpeckers in large diameter deciduous trees (though coniferous trees are also used). Dense vegetation and thickets are also used for roosting. Because cavities of Pileated Woodpecker and Northern Flicker are most often used, it may be important to consider the nesting requirements of these species in ecosystems where the Interior Western Screech-Owl occurs (see Appendix 12).

In the Okanogan National Forest, Pileated Woodpecker nesting sites generally had a high live basal area and tree density, and also a large number of snags in all diameter classes (Madsen 1985). Similar conclusions about the importance of high densities of large trees and snags have been found in other similar western coniferous forests. The Northern Flicker is less selective in stand structural features, and generally nest trees were located either within or close to open forest areas. However, Northern Flickers use old Pileated Woodpecker cavities.

Pileated Woodpeckers in northwestern Montana selected mainly western larch and occasionally Douglas-fir as nest trees (McClelland and McClelland 1999). They used ponderosa pine where there were groves almost entirely composed of ponderosa pine and Douglas-fir. In riparian forests, nest trees were in large black cottonwood and all aspen nest trees were in monospecific groves of aspen (McClelland and McClelland 1999). In northern Montana and in the aspen parklands in Alberta, aspen often is the only tree species that reaches sufficient size for Pileated Woodpecker nesting (Bonar 1997; McClelland and McClelland 1999). In south-central British Columbia, Pileated Woodpeckers nested exclusively in trembling aspen (Harestad and Keisker 1989). In the Okanogan National Forest, Northern Flickers selected ponderosa pine and western larch in greater proportion than Douglas-fir or other species (Madsen 1985). Northern Flickers preferred trembling aspen to conifers near Riske Creek (Wiebe 2001). Diameter at breast height (dbh) of nest trees differed particularly between coniferous and deciduous trees for both species of cavity-nester (Table 1).

In the Okanogan National Forest, Pileated Woodpecker nest trees were exclusively in decay stages 4 and 5 (Madsen 1985). Nest trees in northwestern Montana often had broken tops and fire scars were present on ≥50% of western larch, ponderosa pine, and aspen nest trees (McClelland and McClelland 1999). In northern Oregon, 45% of Pileated Woodpecker nest trees had intact tops, whereas 49% had ≥10% of the top broken off (these were largely ponderosa pine) (Bull 1987). Alternately, 92% of the nest trees in Alberta (mainly aspen) were living but all had signs of heartwood decay and conks were present on 62% of nest trees (Bonar 1997).

Conservation and Management

Status

The Interior Western Screech-Owl is on the provincial *Red List* in British Columbia. It is considered *Endangered* in Canada (COSEWIC 2002).

Summary of ABI status in BC and adjacent jurisdictions (NatureServe Explorer 2002)

BC	ID	MT	OR	WA	Canada	Global
S1	S4	S3S4	S4?	S5	N1	G5T4

Table 1. Dbh (mean ± SD) (cm) of Pileated Woodpecker and Northern Flicker nest trees in several locations.

Forest	Location	*n*	Pileated Woodpecker	*n*	Northern Flicker	Citation
Coniferous	Blue Mountains Oregon	13	75.3 ± 11.7			Bull 1975
Coniferous	Okanogan National Forest	6	84.2 ± 17.5	16	70.4 ± 27.2	Madsen 1985
Coniferous	Northern Montana	89	73.4 ± 1.9			McClelland and McClelland 1999
Coniferous	South central British Columbia	20	40.5 ± 7.1	17	31.9 ± 9.9	Harestad and Keisker 1989
Deciduous trees	Riske Creek, British Columbia			159	33.87 ± 10.34	Wiebe 2001

Trends

Population trends

Population trends are unknown, but is likely slowly declining, as habitat is lost at lower elevations in the Okanagan Valley.

Habitat trends

About half the riparian habitat in the south Okanagan Valley has been lost to urban or agricultural development over the last 50 years (Cannings et al. 1999) and a similar loss has likely occurred in the north Okanagan. This loss is particularly severe in the main valley and less critical along small creeks.

Threats

Population threats

Coastal populations of Western Screech-Owls seem to have suffered significant declines in the last 10 years due to a newly established predator, the Barred Owl (*Strix varia*) (pers. obs.; J. Hobbs, pers. comm.). Barred Owls began nesting on the south coast in the early 1990s and anecdotal evidence points to a concomitant decline in Western Screech-Owl breeding populations since then, both in the Greater Vancouver and Victoria areas (pers. obs.; D. Fraser, pers. comm.). Barred Owls are potentially a threat in the Interior as well (M. Chutter, pers. comm.)

Habitat threats

Habitat loss is the primary threat to the Interior Western Screech-Owl which occurs in riparian woodlands at low elevations in the Okanagan Valley, where approximately half of the suitable habitat has been lost in the last 50 years and most of the remaining habitat is degraded to some extent (Cannings et al. 1999). Livestock grazing, and burning to clear shrubs has reduced or altered suitable habitats along the Nicola Valley (J. Hobbs, pers. comm.)

Legal Protection and Habitat Conservation

The Western Screech-Owl, its nests, and its eggs are protected from direct persecution by the provincial *Wildlife Act*.

Some habitat is protected in the following parks: Coldstream Regional Park, Inkaneep Provincial Park, Okanagan Mountain Provincial Park, South Okanagan Grasslands Provincial Park, White Lake Grasslands Provincial Park, Woodhaven Regional Park, Mission Creek, Duck Lake, and Lac du Bois parks.

Habitat conservation may be partially addressed by the old forest retention targets (old growth management areas), riparian reserves, and wildlife tree retention area recommendations in the results based code.

The results based code riparian guidelines likely afford little direct protection for Interior Western Screech-Owl habitat, since many territories are along very small non fish bearing streams and wetlands. Harvesting is permitted within the riparian management zones often resulting in loss of large diameter trees and snags for nesting and roosting. It is also likely that upland forest habitat is also important for foraging.

Special riparian management zones outlined in the Okanagan Shuswap Land and Resource Management Plan are similar to those of the results based code.

Identified Wildlife Provisions

Sustainable resource management and planning recommendations

Because this species depends largely on woodpecker cavities, particularly those of Northern Flickers and Pileated Woodpeckers, for nest sites, management practices that benefit woodpeckers will also enhance habitat for the Western Screech-Owl.

- ❖ The objective for this species is to maintain wildlife trees and green recruitment trees for nesting across the breeding range and over time. Consider wildlife tree retention (WTR) areas, RMAs, and OGMA objectives for this species in the following forest districts: Okanagan Shuswap, Kamloops, Cascades, and Arrow Boundary.

- Blocks should be assessed to identify potentially suitable WTR areas. Suitable WTR areas for this species should be based on the information in Table 2.
- It is recommended that salvage not occur in WTR areas and OGMAs established to provide habitat for this species. In addition, these areas should be designed to include as many suitable wildlife trees as possible and that they should be maintained over the long term (>80 years).
- Maintain forested riparian management zones.

Wildlife habitat area

Goal

Because few nest areas are known for this subspecies, these sites should be established as WHAs. Suitable habitat should be managed through the wildlife tree retention within landscape level planning objectives.

Feature

Establish WHAs at known nest sites or occupied residences. Residency is indicated by detections during the breeding season.

Size

Typically between 5 and 30 ha. Size should be based on estimated home range size using habitat suitability and number of occupied breeding territories. Areas of highly suitable habitat may have more than one occupied breeding territory.

Design

Design the WHA to minimize disturbance and maintain suitable foraging habitat. The WHA should include a 5–12 ha core area for the nest area and may include a ~100 m management zone (i.e., smaller WHAs may be managed as a no harvest core area only). The management zone should include suitable foraging habitat. Other features to include are large diameter snags (particularly black cottonwood, trembling aspen, water birch, and broadleaf maple) with suitable nest cavities.

General wildlife measures

Goals

1. Maintain nesting and foraging habitat.
2. Maintain an adequate supply of suitable wildlife trees and associated nest and roost cavities.
3. Maintain a healthy riparian habitat.
4. Minimize disturbance to roost and nest sites.
5. Maintain native vegetation.
6. Maintain/encourage deciduous component in riparian and conifer stands.
7. Ensure WHA is windfirm.
8. Maintain riparian areas in properly functioning condition.

Measures

Access

- Do not construct roads or stream crossings in the core area. Within the management zone, avoid constructing roads or stream crossings.

Table 2. Preferred WTP characteristics for the Interior Western Screech-Owl

Attribute	Characteristics
Size (ha)	≥2.5 ha
Location	PPxh, PPdh, IDFxh, IDFxw, IDFdk, IDFmw; riparian areas
Tree features	visible woodpecker or natural cavities
Tree species	deciduous preferred; trembling aspen, black cottonwood, water birch, Douglas-fir, possibly ponderosa pine, and western larch
Tree size (dbh)	deciduous spp.: 34–44 cm or larger; coniferous spp. 74–85 cm or larger; in the absence of trees with the preferred dbh, trees with ≥30 cm dbh should be retained for recruitment
Wildlife tree class	2–6

Harvesting and silviculture

- Do not harvest or salvage within the core area.
- In PP and IDF zones, selective harvest of ≤20% basal area may occur within the management zone provided no suitable wildlife trees (see Table 2) are removed.
- Do not harvest or salvage within the management zone during the breeding season (1 March to 15 August).
- Retain deciduous species.
- Within riparian management zones, retain >60% of trees including all suitable wildlife trees (see Table 2).

Pesticides

- Do not use pesticides.

Range (BG, PP, and IDF zones)

- Plan livestock grazing (timing, distribution, and level of use) to maintain desired structure of plant community, desired stubble height, and browse utilization.
- Do not place livestock attractants within WHA.
- Do not burn understorey vegetation.

Recreation

- Do not construct trails within 50 m of a known nest site.

Additional Management Considerations

Consider fencing stream or stock-watering works to limit the access of livestock to a stream within the WHAs.

Consider using nest-boxes if wildlife trees and other trees with suitable cavities have been felled for safety reasons.

Information Needs

1. Habitat use and home range size. It would be very useful to find out the degree to which owls use coniferous forests adjacent the riparian zone during foraging bouts.
2. Impact of Barred Owl predation and any opportunity to design WHAs to reduce/minimize predation by Barred Owls.

Cross References

Lewis's Woodpecker, Yellow-breasted Chat

References Cited

American Ornithologists' Union (AOU). 1957. Check-list of North American birds. 5th ed. Am. Ornithol. Union, Wash., D.C.

_____. 1983. Check-list of North American birds, 6th ed. Am. Ornithol. Union, Wash., D.C.

_____. 1998. Check-list of North American birds, 7th ed. Am. Ornithol. Union, Wash., D.C.

Bonar, R.L. 1997. Pileated Woodpecker habitat ecology in boreal forests: 1996–1997 progress report. Weldwood of Canada Ltd., Hinton, Alta. 43 p.

Bull, E.L. 1975. Habitat utilization of the Pileated Woodpecker, Blue Mountains, Oregon. M.Sc. thesis. Oreg. State Univ., Corvallis, Oreg. 58 p.

_____. 1987. Ecology of the Pileated Woodpecker in north-eastern Oregon. J. Wildl. Manage. 51:472–481.

Campbell, R.W., N.K. Dawe, I. McTaggart-Cowan, J.M. Cooper, G.W. Kaiser, and M.C.E. McNall. 1990. The birds of British Columbia. Vol. II: Nonpasserines. Diurnal birds of prey through woodpeckers. Royal B.C. Mus., Victoria, B.C., and Can. Wildl. Serv., Delta, B.C. 636 p.

Cannings, R.J. 1997. A survey of the Western Screech-Owl (*Otus kennicottii macfarlanei*) in the interior of British Columbia. B.C. Min. Environ., Lands and Parks, Victoria, B.C. Unpubl. rep.

Cannings, R.J. and T. Angell. 2001. Western Screech-Owl. *In* Birds of North America, No. 597. A. Poole and F. Gill (editor). Birds of North America, Inc., Philadelphia, Penn.

Cannings, R.J., E. Durance, and L. Scott. 1999. South Okanagan Ecosystem Recovery Plan: scientific assessment. B.C. Environ., Penticton, B.C. Unpubl. rep.

Committee on the Status of Endangered Wildlife in Canada (COSEWIC). 2002. Canadian Species at Risk. www.speciesatrisk.gc.ca

Ellsworth, E. and J.R. Belthoff. 1997. Sex-biased dispersal of young Western Screech-Owls (*Otus kennicottii*) in southwestern Idaho. *In* Biology and conservation of owls of the Northern Hemisphere: 2nd Int. Symp. J.R. Duncan, D.H. Johnson, and T.H. Nicholls (editors). Feb. 5–9, 1997, Winnipeg, Man. U.S. Dep. Agic. For. Serv., North Cent. Res. Stn., Gen. Tech. Rep. 190, pp. 155–159.

Gehlbach, F.R. 2003. Body size variation and evolutionary ecology of eastern and western screech-owls. Southwest. Nat.

Harestad, A.S. and D.G. Keisker. 1989. Nest tree use by primary cavity-nesting birds in south central British Columbia. Can. J. Zool. 67:1067–1073.

Hekstra, G.P. 1982a. A revision of the American screech-owls (Otus: Strigidae). Ph.D. thesis. Vrije Universiteit te Amsterdam, Amsterdam, Netherlands.

_____. 1982b. Description of twenty-four new subspecies of American owls (Aves: Strigidae). Bull. Zool. Mus. Universiteit Amsterdam 9:49–63.

König, C., F. Wieck, and J.-H. Becking. 2000. Owls: a guide to the owls of the world. Yale Univ. Press, New Haven, Conn. 462 p.

Madsen, S.J. 1985. Habitat use by cavity-nesting birds in the Okanogan National Forest, Washington. M.Sc. thesis. Univ. Wash., Seattle, Wash. 113 p.

Marshall, J.T. 1967. Parallel variation in North and Middle American screech-owls. West. Found. Vertebr. Zool. Monogr. 1:1–72.

McClelland, B.R. and P.T. McClelland. 1999. Pileated Woodpecker nest and roost trees in Montana: links with old-growth and forest "health." Wildl. Soc. Bull. 27:846–857.

NatureServe Explorer. 2002. An online encyclopaedia of life. Version 1.6. NatureServe. Arlington, VA. Available at http://www.natureserve.org/explorer/

Peters, J.L. 1940. Check-list of the birds of the world, Vol. 4. Harvard Univ. Press, Cambridge, Mass.

Wiebe, K.L. 2001. Microclimate of tree cavity nests: is it important for reproductive success in Northern Flickers? Auk 118(2):412–421.

Personal Communications

Chutter, M. 2001. Min. Water, Land and Air Protection, Victoria, B.C.

Fraser, D. 2001. Min. Water, Land and Air Protection, Victoria, B.C.

Hobbs, J. 2001. Min. Water, Land and Air Protection, Victoria, B.C.

LEWIS'S WOODPECKER

Melanerpes lewis

Original[1] *prepared by Martin Gebauer*

Species Information

Taxonomy

The Lewis's Woodpecker is currently placed in the genus *Melanerpes*, a genus with 21 species (Tobalske 1997). It has often been placed in the monotypic genus *Asyndesmus* (Bock 1970; AOU 1983). Five other *Melanerpes* species occur in North America (north of Mexico): Red-headed Woodpecker (*M. erythrocephalus*), Acorn Woodpecker (*M. formicivorus*), Golden-fronted Woodpecker (*M. aurifrons*), Red-bellied Woodpecker (*M. carolinus*), and Gila Woodpecker (*M. uropygialis*) (NGS 1999). The Lewis's Woodpecker is considered to be closely related to the Red-headed Woodpecker and possibly the Acorn Woodpecker (Tobalske 1997). No subspecies of Lewis's Woodpecker are recognized (AOU 1983).

Description

The upperparts of adult Lewis's Woodpecker are a glossy greenish-black except for a narrow grey collar. The face is a dark red and the breast is grey, shading into rose on the abdomen, flanks, and sides. Young are similar to adults but lack the red face and grey collar. In flight, its overall dark appearance, large size, and slow, steady wingbeats give it a crow-like appearance (Bent 1939). Flight is not undulating like that of other woodpeckers (e.g., genus *Picoides*) (Godfrey 1986; NGS 1999).

Distribution

Global

The Lewis's Woodpecker is restricted to North America, breeding from southern British Columbia through the western United States to California and southern New Mexico, and east to western Oklahoma and Nebraska (Bent 1939; Tobalske 1997). Its distribution appears to be closely related to the presence of ponderosa pine (*Pinus ponderosa*) (Tobalske 1997).

Lewis's Woodpeckers winter within the southern portion of their breeding range as far north as southwestern Oregon, central Utah, and central Colorado. It winters south of its breeding range to northern Baja California Norte, Chihuahua, and Sonora, Mexico (Howell and Webb 1995; Tobalske 1997).

British Columbia

The Lewis's Woodpecker breeds locally throughout the southern Interior of British Columbia from the Similkameen Valley, east to the East Kootenay (e.g., Invermere south to Newgate and the Tobacco Plains) and north to the Chilcotin-Cariboo area (Campbell et al. 1990, Cooper and Beauchesne 2000). It is most abundant in the south Okanagan (Cannings et al. 1987). Breeding has been documented in Golden and Revelstoke, but these populations appear to have been extirpated (Cooper et al. 1998). Individuals have been seen recently in mature cottonwood stands in the Robson Valley of east-central British Columbia although breeding there has not yet been documented (L. Ingham, pers. comm.). Lewis's Woodpecker was a former abundant breeder in the Lower Mainland and on southeastern Vancouver Island between the 1920s and 1940s, when extensive clearcuts with abundant snags were available. Breeding in this region was last confirmed in 1963 (Campbell et al. 1990).

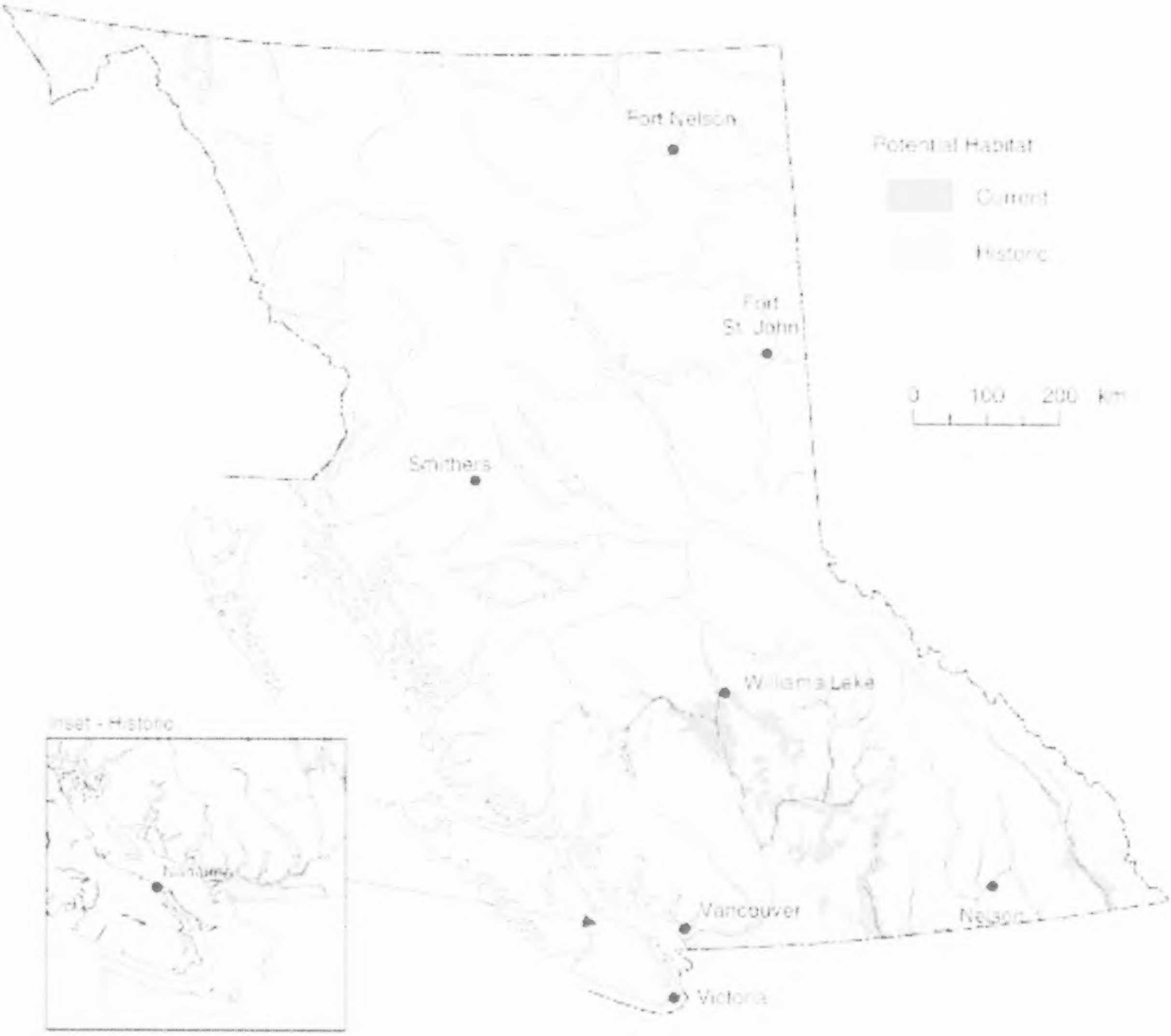
A few birds winter in the south Okanagan with the centre of abundance from Vaseux Lake to Summerland. In winter it appears to be restricted to residential areas and orchards (Cannings et al. 1987).

---

[1] Volume 1 account prepared by T. Manning

Lewis's Woodpecker

(Melanerpes lewis)


Fort Nelson
Potential Habitat
Current
Historic
Fort St. John
0 100 200 km
Smithers
Williams Lake
Inset - Historic
Nanaimo
Vancouver
Nelson
Victoria

Note: This map represents a broad view of the distribution of potential habitat used by this species. The map is based on several ecosystem classifications (Ecoregion, Biogeoclimatic and Broad Ecosystem Inventory), as well as current knowledge of the species' habitat preferences. This species may or may not occur in all areas indicated. More detailed maps are available for this species from the Ministry of Sustainable Resource Management.

Forest region and districts

Coast: Chilliwack, South Island (historical)

Southern Interior: 100 Mile House, Arrow Boundary, Cascades, Central Cariboo, possibly Columbia, Headwaters, Kamloops, Kootenay Lake, Okanagan Shuswap, Rocky Mountain

Ecoprovinces and ecosections

CEI: FRB, possibly CAB, CAP, CCR, CHP, QUL

COM: FRL (historical)

GED: LIM, NAL (historical)

SIM: CCM, EKT, ELV, EPM, MCR, SCM, SFH, SPK, SPM, UCV

SOI: GUU, NIB, NOB, NOH, NTU, OKR, PAR, SCR, SHB, SOB, SOH, STU, THB, TRU

Biogeoclimatic units

BG: xh1, xh2, xh3, xw, xw1, xw2

ICH: dw, mk1, mw2, mw3, xw

IDF: dk1, dk2, dk3, dk4, dm, dm1, dm2, dw, mw1, mw2, un, xh1a, xh2a, xm, xw, xw2

PP: dh1, dh2, xh1, xh2

MS: un, dk

SBPS: mk, xc

Broad ecosystem units

AB, AC, BS, CR, DF, DL, DP, OV, PP, RR, SS, UR, WR

Elevation

In British Columbia, the Lewis's Woodpecker has been observed nesting at elevations ranging from 250 to 1160 m (Campbell et al. 1990; Cooper and Beauchesne 2000). All nests above 1000 m were in burns (Cooper and Beauchesne 2000).

Life History

Diet and foraging behaviour

The diet of Lewis's Woodpeckers varies with the seasonal abundance of food items, but includes primarily free-living (i.e., not wood-boring) insects, acorns and other nuts, seed and berries, and wild and agricultural fruit (Sherwood 1927; Bent 1939; Bock 1970; Cannings et al. 1987; Tobalske 1997). Insects taken include ants, butterflies, bees, wasps, beetles, crickets, and grasshoppers (Cannings et al. 1987; Tobalske 1997). Succulent fruits taken include apples, cherries, peaches, Saskatoon (*Amelanchier alnifolia*), hawthorn (*Crataegus* spp.), dogwood (*Cornus* spp.), elderberry (*Sambucus* spp.), and sumac (*Rhus* spp.) (Cannings et al. 1987; Tobalske 1997).

During the breeding season, Lewis's Woodpeckers primarily forage by hawking insects in the air, but will also glean insects from tree trunks, branches, bushes, and the ground (Bock 1970; Short 1982 Raphael and White 1984). Extended feeding flights of greater than 30 minutes have been observed (Bent 1939; Beauchesne, pers. obs.). Snags or dead-topped trees and human-made structures such as telephone poles and fence posts that provide an open view are used for perching when hawking insects. Foraging substrates in the Sierra Nevada were primarily snags (i.e., 66% of 88 foraging bouts), with ground and live trees used to a lesser extent (Raphael and White 1984). The most common position used on the tree was the trunk (i.e., 68%) (Raphael and White 1984). Although no studies in British Columbia have specifically investigated diet, free flying insects and fruits, especially berries, seem to be the most important food items during breeding season (Cannings et al. 1987; Beauchesne, pers. obs.).

Lewis's Woodpeckers also collect and store nuts, such as acorns, primarily in the winter, and in some areas, corn in the fall (Hadow 1973; Vierling 1997). On several occasions in the Penticton and Summerland areas, it has been observed storing acorns of the introduced red oak (*Quercus rubra*) in the cracks of power poles (Cannings et al. 1987). Interestingly, Lewis's Woodpeckers first husk acorns, often cutting them into pieces, before storing them (Bent 1939; Ehrlich et al. 1988). Oak trees, cottonwood, and cracked telephone poles are some of the principal storage areas reported (Tobalske 1997). In the East Kootenay trench, during the breeding season, birds were observed caching beetles in the bark of ponderosa pine and in the cracks of utility poles (Beauchesne, pers. obs.).

Reproduction

Dates for 69 clutches in British Columbia ranged from 16 April to 27 June, with 53% recorded between 23 May and 11 June (Cannings et al. 1987; Campbell et al. 1990). Average size of 30 clutches ranged from two to eight eggs with 63% having four to six eggs (Campbell et al. 1990). Bent (1939) has reported clutch sizes of up to nine eggs. Average incubation period ranges from 13 to 14 days (Ehrlich et al. 1988) with up to 16 days reported (Tobalske 1997). Dates for 165 broods in British Columbia ranged from 5 May to 3 August with 51% recorded between 12 June and 6 July (Campbell et al. 1990). Sizes of 28 broods ranged from one to five young with 89% having two to four young (Campbell et al. 1990). Fledgling period ranges from 28 to 34 days (Ehrlich et al. 1988; Tobalske 1997).

Lewis's Woodpeckers have been reported to be colonial in some areas (Currier 1928; Linder and Anderson 1998). Cooper and Beauchesne (2000) found three active nests in a live ponderosa pine near Newgate, in the East Kootenay in 1997. In 1998, the same tree harboured two active Lewis's Woodpecker pairs and one American Kestrel pair. The Lewis's Woodpeckers from this nest tree primarily travelled to forage within the open burn on the edge of Lake Koocanusa (Beauchesne, pers. obs). Concentrations of Lewis's Woodpeckers have also been found in the Finlay Creek Burn (31 nesting pairs) and the Dutch Creek burn (seven nesting pairs) of the East Kootenay Trench (Cooper and Gilles 1999).

Site fidelity

Site fidelity is difficult to determine because very few researchers have banded these birds, marking individuals (Tobalske 1997). However, the same cavities are often used in successive years (Bent 1939; Tobalske 1997). In Wyoming, 37% of nest cavities found in 1993 were reused in 1994 (Linder and Anderson 1998). In the East Kootenay Trench, 60% of nest cavities found in 1997 were reused in 1998 (Cooper and Beauchesne 2000). In addition, where cavities had been destroyed or removed between breeding seasons, a pair was often found nesting nearby (Cooper and Beauchesne 2000).

Home range

Little is known of the home range of Lewis's Woodpeckers. Adults defend the immediate vicinity of nesting trees and mast stores in fall and winter (Hadow 1973; Tobalske 1997). In the Blue Mountains of Washington and Oregon, territory size of 6.1 ha/pair has been reported (Thomas et al. 1979). In the East Kootenay Trench, birds were observed travelling more than 1 km from their nest to forage, suggesting that some home ranges may be extensive (Beauchesne, pers. obs.).

Movements and dispersal

Most birds in British Columbia are migratory arriving within the first 2 weeks of May, although early arrivals appear in mid-April. Large flocks gather in late summer, wandering through foraging habitats in their local ranges. Peak autumn movement is between late August and early September. Few birds remain after the end of September (Campbell et al. 1990). One notable migration of Lewis's Woodpeckers was observed on 7 September 1971, when 42 birds in groups of two and three, moved past McIntyre Bluffs (Cannings et al. 1987).

Lewis's Woodpeckers wander irregularly, having been reported as far north as Masset on the Queen Charlotte Islands and at Takla Lake in the central Interior of British Columbia (Campbell et al. 1990).

Habitat

Structural stage

2: herb – foraging for ants, beetles and other insects
3a: low shrub – shrub stage for foraging when insects are abundant
3b: high shrub – possibly used for foraging when insects are abundant
5: immature forest – particularly in black cottonwood stands
6: mature forest – black cottonwood, ponderosa pine and oak stands
7: old-growth forest – black cottonwood, ponderosa pine and oak stands

Important habitats and habitat features

Nesting

Typical breeding habitat in the interior of British Columbia includes deciduous groves (e.g., mature cottonwood stands), open ponderosa pine forests, recent burns, sagebrush/pine/bunchgrass grasslands, agricultural areas, and urban environments (Campbell et al. 1990; Cooper et al. 1998; Cooper and Beauchesne 2000).

Good breeding habitat is characterized by an open canopy (e.g.,<25% crown closure), the availability of a suitable dead or dying tree (>30 cm dbh) for a nesting site, and understorey vegetation that provides an abundant supply of insects. Where closed canopy riparian stands are used, trees at the edge of the stand are usually used for nesting (Fraser et al. 1999). In the East Kootenay, a high density (i.e., 59% of 85 nests) of breeding Lewis's Woodpeckers were found in areas that were burned by stand-destroying fires (i.e., characterized by open space with a few remaining snags) between 13 and 28 years ago (Cooper and Beauchesne 2000). Bock (1970) indicated that burns <10 years and >40 years are likely of low use because of successional factors. However, in southwestern Idaho, Saab and Dudley (1998) found a high density of Lewis's Woodpecker, 2–4 years after a stand-destroying fire, in areas that had been salvage logged. In Wyoming, 98% of Lewis's Woodpecker nests studied by Linder and Anderson (1998) were found within burned stands despite these stands comprising only 26% of the 11 100 ha study area.

In Colorado, Vierling (1997) found that mature cottonwood forests were critical for breeding and mast storage, whereas little breeding was evident in ponderosa pine forests; the author suggests this is probably due to a lack of suitable ponderosa pine forest in that area. In the Okanagan, Cannings et al. (1987) reported a high percentage of documented breeding Lewis's Woodpeckers in black cottonwood (*Populus balsamifera*), but attribute this partially to observer bias. In contrast, in the East Kootenay, Cooper and Beauchesne (2000) found low numbers of breeding pairs in black cottonwood stands despite the relative abundance of this habitat in some areas. This may have been because riparian cottonwood stands tend to be bordered by dense conifer stands rather than the open grasslands found in the Okanagan Valley and Thompson Basin (Cooper et al. 1998). In the Cariboo-Chilcotin, Lewis's Woodpecker use wide-spaced large diameter Douglas-fir (*Pseudotsuga menziesii*) trees in the grasslands (grassland/Douglas-fir ecotone), and mature cottonwood groves. The different use of forest types may indicate that other structural components are more important than forest type for breeding habitat selection.

Sousa (1983) suggests that good Lewis's Woodpecker breeding habitat is positively correlated with increased shrub density, which supplies an abundance of insects (<25% shrub closure has no value, from 25 to 50% there is an increase in value, and >50% or greater is optimal). However, recently other researchers have found that Lewis's Woodpeckers selected breeding habitat with much lower shrub densities (i.e., 16.1% in Wyoming and 13.4% in California; Linders and Anderson 1998). This is more consistent with the habitat in the East Kootenay Trench, where the average percentage of cover by shrubs at nesting sites was 16.5% (*n* = 109; range 0–90%) (S.M. Beauchesne, unpubl. data). Most of the sites with a high shrub density (*n* = 11, average density 40%) were in the Dutch Creek burn, an area considered to be of limited future suitability to Lewis's Woodpecker because of conifer regeneration (Cooper and Gilles 2000). Excluding the Dutch Creek burn data, the shrub closure for the East Kootenay Trench was 14.4% (S.M. Beauchesne, pers. comm.).

Lewis's Woodpeckers nest in living and dead deciduous and coniferous trees in British Columbia with ponderosa pine (47% of 215 nests) and black cottonwood (33%) the most common nest trees reported (Campbell et al. 1990). Use of human-made structures such as utility poles (eight records from 215 nests), fence posts (one record from 215 nests; Campbell et al. 1990), and buildings (one record of a cavity in roof of a house; Beauchesne, pers. obs.) is also possible. Other tree species used in the Interior included domestic cherry and apple, ornamental maple, Douglas-fir, western larch (*Larix occidentalis*), trembling aspen (*Populus tremuloides*), alder, (*Alnus rubra*) paper birch (*Betula papyrifera*), ornamental willow, elm, and Lombardy poplar (Cannings et al. 1987; Cooper and Beauchesne 2000). Trees previously used for nesting in coastal areas included Garry oak (*Quercus garryana*) and bigleaf maple (*Acer macrophyllum*) (Cooper et al. 1998). Garry oak (known as Oregon white oak in the United States) is still used to a large extent in Wasco County, Oregon (Galen 1989). In the Blue Mountains of Oregon and Washington, Lewis's Woodpecker used 72% cottonwood, 12% ponderosa pine (*Pinus ponderosa*), 10% juniper, 4% willow, and 2% fir for nesting ($n = 49$) (Thomas et al. 1979).

Lewis's Woodpeckers can excavate their own cavities, but will reuse old Lewis's Woodpecker, Northern Flicker (*Colaptes auratus*), or Hairy Woodpecker (*Picoides villosus*) nest holes or natural cavities (Tobalske 1997). Live trees and dead trees with heartrot provide suitable nesting trees. Softer snags are preferred.

In British Columbia, nest heights ($n = 212$) ranged from 1.0 to 30.5 m with most nests (64%) recorded between 3.5 and 9.0 m (Campbell et al. 1990). In 1998, a nest cavity in a 1.6 m stump in the East Kootenay was only 60 cm above the ground, the lowest nest cavity height reported for Lewis's Woodpecker (Cooper and Beauchesne 2000).

The characteristics of Lewis's Woodpecker nest trees vary between locations (see Table 1), and dbh varies between nest tree species (see Table 2).

Table 1. Characteristics (mean ± SD) of Lewis's Woodpecker nests trees

Location	Species	Citation	*n*	dbh (cm)	Height (m)	Nest height (m)
Colorado	Cottonwood	Vierling 1997	47	112.6 ± 38.8	20.4 ± 5.2	11.1 ± 3.4
Wyoming	Ponderosa pine	Linder 1994	35	47.8 ±8.4	10.6 ± 3.0	7.5 ± 2.7
Sierra Nevada	Pine/fir forests	Raphael and White 1984	37	66.5		
British Columbia	Ponderosa pine and cottonwood	Campbell et al. 1990	215			1.0–30.0 range
Oregon	Oregon white oak and ponderosa pine	Galen 1989	53	66 ± 20.8		
British Columbia	Ponderosa pine and Douglas-fir	Cooper and Beauchesne 2000	85	52 ± 19.1		

Table 2. Dbh[a] of Lewis's Woodpecker nest trees by species in the eastern foothills of Mount Hood in Oregon (Galen 1989) and in the East Kootenay of British Columbia (Cooper and Beauchesne 2000)

Tree Species	Oregon		British Columbia	
	n	dbh (cm)	*n*	dbh (cm)
Ponderosa pine	22	75.6 ± 19.2	34	59.2 ± 21.9
Douglas-fir	5	72.1 ± 16.2	30	48.3 ± 13.6
Black cottonwood	3	65.2 ± 21.6	3	71.0 ± 33.0
Oregon white oak	23	56.1 ± 19.8		
Birch			4	47.5 ± 13.4
Aspen			6	34.2 ± 11.3
Western larch			3	47.0 ± 9.9

[a] Mean ± SD.

Foraging

During the breeding season in British Columbia, foraging areas include breeding habitats, open forests and valley bottoms, deciduous groves near lakes and streams, burns, logged areas, agricultural habitats such as orchards and farms, rural gardens, and urban areas. In British Columbia in winter, foraging is generally restricted to residential areas, orchards, and mature cottonwood groves (Cannings et al. 1987).

Broken-topped or large-limbed living or dead trees are used as hawking perches.

Conservation and Management

Status

The Lewis's Woodpecker is on the provincial *Blue List* in British Columbia. It is considered a species of *Special Concern* in Canada (COSEWIC 2002).

Summary of ABI status in BC and adjacent jurisdictions (NatureServe Explorer 2002)

BC	AB	WA	ID	MT	Canada	Global
S3B, SZN	SH	S3B, SZN	S4B, SZN	S4B, SZN	N3	G4

Trends

Population trends

Breeding Bird Survey results for the period 1966 to 1999 indicate a significant decline (-2.3%/yr) in Lewis's Woodpecker populations across North America (Sauer et al. 2000). Declines of -2.2% were observed in western North America. Significant declines were noted in Montana (-5.2%) and Washington (-8.4%) (Sauer et al. 2000). Sauer et al. (2002) did not report a significant trend in British Columbia for the same period; however, sample sizes were likely too small to obtain significant results. Cooper et al. (1998) and Fraser et al. (1999) report that long-term population declines have been documented in British Columbia and that populations may still be declining. Once abundant, populations on southeastern Vancouver Island and near Vancouver have been extirpated (Campbell et al. 1990).

Population size of Lewis's Woodpecker in the province was estimated to be a maximum of 600 pairs in 1990, but this estimate may have been conservative because some areas had not yet been surveyed (Fraser et al. 1999). For example, based on inventory work in 1997 and 1998 in the East Kootenay Trench, this region has a population estimate of 100–150 pairs (Cooper and Beauchesne 2000).

Habitat trends

Potential suitable habitat is undoubtedly declining as stands of mature ponderosa pine, Douglas-fir, and black cottonwood are harvested for timber, urban development, and firewood. Stands of old black cottonwood along the South Thompson River, east of Kamloops, have been severely impacted by cattle activity, urban development, and changing agricultural practices (Cooper et al. 1998). Helicopter logging of mature ponderosa pine still occurs in some areas where steep terrain and other access issues prevented their removal in the past. Some low-lying areas in the East Kootenay have been flooded by hydroelectric reservoirs (Cooper et al. 1998).

Intensive grazing may result in elimination of brushy or grassy forest understoreys, that may be important to Lewis's Woodpeckers. Forest fire suppression has resulted in encroachment by regenerating conifers into open ponderosa pine forests, which has reduced suitable habitat for Lewis's Woodpeckers.

Threats

Population threats

Competition with European Starlings may be a problem in some areas, but Lewis's Woodpeckers appear to be more successful in competing with starlings than other *Melanerpes* woodpeckers such as the Red-bellied Woodpecker (Cannings et al. 1987; Ingold 1994). Vierling (1998) recorded 78 interspecific interactions between starlings and Lewis's

Woodpeckers during 418 hours of monitoring. Of the 59 Lewis' Woodpecker pairs, only one lost its nest cavity to starlings. In the Okanagan and the East Kootenay Trench, starlings and Lewis's Woodpeckers seem to be able to coexist, having been observed nesting in the same habitat, occasionally sharing a nest tree (Cannings et al. 1987; Cooper and Beauchesne 2000). In contrast, Sorenson (1986) found a correlation between the rapid increase of starlings in Salt Lake City and the rapid decline of Lewis's Woodpeckers. It is possible that the effects of competition depend on resource availability (i.e., number of cavities) and population size of the competitors (i.e., if Lewis's Woodpecker are vastly outnumbered by starlings and cavities are scarce, the energetic cost of competition may be too great).

Collisions with cars may be a cause of mortality in some areas (Tobalske 1997). Both members of a pair nesting close to Highway 95 were found dead by the road in 1997 (Cooper and Beauchesne 2000).

Habitat threats

Fire suppression in the Okanagan and other interior areas has resulted in dense stands of ponderosa pine and Douglas-fir in forest understoreys, making some stands unsuitable for Lewis's Woodpecker (Cooper et al. 1998). Vierling (1997) found that Lewis's Woodpeckers in southeastern Colorado avoided dense stands of trees at all times of the year. Other factors such as grazing, logging, and possibly climate change have resulted in many more younger and smaller trees, fewer older and larger trees, accumulation of fuel loads, reduced herbaceous production, and associated changes in ecosystem structure, fire hazard, and wildlife fauna (Covington and Moore 1994).

Loss of nest trees through logging and firewood collection is a significant threat. In coastal areas of southwestern British Columbia, the cutting of snags for firewood and as a WCB safety requirement for the Forest Service may have contributed to the decline and eventual extirpation of Lewis's Woodpeckers (Campbell et al. 1990). Removal of Garry Oak on Vancouver Island likely resulted in declines in numbers there (Fraser et al. 1999).

Use of insecticides and pesticides in orchards and gardens may reduce insect populations, an important food resource during the breeding season.

Legal Protection and Habitat Conservation

The Lewis's Woodpecker, its nests, and its eggs are protected in Canada and the United States under the *Migratory Birds Convention Act* and in British Columbia under the provincial *Wildlife Act*.

Several breeding sites are protected in provincial parks, ecological reserves, and wildlife management areas. According to MELP (1998), only 8% (i.e., 7731 ha) of potentially suitable Lewis's Woodpecker habitat in the south Okanagan is currently designated as conservation lands. Remaining suitable lands are found on Crown land (34 1999 ha; 37%); Indian Reserves (22 110 ha; 24%); and private land (27 975 ha; 30%). A number of new provincial parks have been announced in the south Okanagan through the Okanagan-Shuswap Land and Resource Management Plan process. Some of the more important parks for Lewis's Woodpecker include White Lake Grasslands and South Okanagan Grasslands.

The riparian and biodiversity guidelines under the results based code, particularly recommendations for wildlife tree retention, may partially address the requirements of this species. The feasibility of using the wildlife tree retention area recommendations or the wildlife habitat feature designation should be considered prior to establishing a WHA for this species and should be used to manage for individual pairs.

Identified Wildlife Provisions

Sustainable resource management and planning recommendations

- Maintain open forests, dominated by ponderosa pine, black cottonwood, or Douglas-fir, with some large snags and recruitment trees.
- Provide naturally vegetated linkages between riparian areas, semi-open forest, and reserve areas of similar quality.

- ❖ Consider the relative location and proximity of other preferred habitats (e.g., recent burns, partially logged areas showing low crown closures and desirable habitat attributes such as snags and large hardwoods, orchards, crop fields, or pastures).
- ❖ Since this species is largely dependent on wildlife trees, it is best managed through the wildlife tree retention objectives established within landscape level plans. Blocks should be assessed to identify potentially suitable WTR areas. Table 3 provides recommendations for wildlife tree retention objectives for this species.
- ❖ It is recommended that salvage not occur in WTR areas established to provide habitat for this species. In addition, these areas should be designed to include as many suitable wildlife trees as possible and maintained over the long term.

Wildlife habitat area

Goal

Maintain suitable nesting habitat for multiple pairs.

Feature

Establish WHAs over breeding aggregations of three or more pairs.

Size

Typically between 5 and 50 ha but will depend on area of suitable habitat.

Design

The WHA should contain open mature or old growth ponderosa pine or Douglas-fir forests, preferably with <25% canopy closure, with presence of large diameter dead or live snags (preferably ≥45 cm dbh; minimum 30 cm dbh) OR mature deciduous stands (e.g., paper birch, trembling aspen, and black cottonwood) with variable canopy closure (range from approximately 5–80% with presence of large trees (preferably ≥45 cm dbh; minimum 30 cm dbh).

General wildlife measure

Goals

1. Provide an adequate supply of large diameter live and dead wildlife trees suitable for foraging and nesting.
2. Maintain an open canopy.
3. Maintain the integrity of nesting habitat.
4. Maintain shrub cover.

Measures

Access

- Do not construct roads unless there is no other practicable option.

Harvesting and silviculture

- Do not harvest or salvage mature timber. When harvesting is approved, follow the measures below.

Table 3. Preferred wildlife tree patch features for the Lewis's Woodpecker

Attribute	Characteristics
Size (ha)	variable; may be quite small (1 ha)
Location	if possible, on west side of valleys; proximity to large open areas important
Tree features	large dbh; evidence of heartrot infection or broken tops or limbs
Tree species	ponderosa pine; black cottonwood; Douglas-fir
Tree size (dbh)	in general: 55–80 cm; specifically: 66–87* cm ponderosa pine, 68–96* cm cottonwood, 52–66* cm Douglas-fir; in the absence of trees with the preferred dbh, trees ≥30 cm may be retained for recruitment
Wildlife tree class	2–4 for ponderosa pine; 4–7 for Douglas-fir (a mix would be ideal, but preference would be for lower end of decay range to maximize current suitability and longevity)

* Weighted mean pooled S.D.

- Protect and retain all ponderosa pine and black cottonwood live and dead trees ≥30 cm dbh for nesting, perching, and foraging.
- Maintain at least six standing dead trees per ha. Where it is not possible to retain six ≥45 cm, use the largest available. The highest practical density of snags is preferred. Hazardous snags or trees can be incorporated into group reserves (plan as no-work zones if appropriate); otherwise maintain snags within the operational setting as described in the *Wildlife/Danger Tree Assessor's Course Workbook*. Use partial cutting silvicultural systems to maintain widely spaced (<25% canopy cover) late seral ponderosa pine and Douglas-fir.
- Topping large diameter snags may be appropriate in areas where standing dead trees are few.
- Additional potential nest sites in intensely managed stands may be provided by leaving some high-cut (5 m in height) stumps of large (≥45 cm dbh) ponderosa pine or black cottonwood.

Pesticides

- Do not use pesticides.

Range

- Limit browse utilization by livestock to no more than 10%.

Additional Management Considerations

Open forests resulting from regularly occurring burns provide prime nesting and foraging habitat for Lewis's Woodpeckers (Cooper and Beauchesne 2000). Naturally occurring fire regimes in the ponderosa pine and Douglas-fir biogeoclimatic zones should be encouraged, and where possible, fire suppression should be minimized. The use of prescribed burning is a potentially useful habitat management tool.

A high potential for habitat enhancement exists through a combination of mechanical removal of regenerating conifers and selective logging of mature timber. Planting of suitable "snags" in open habitats where natural snags are absent may be beneficial as well.

Maximize the number of snags retained in suitable habitats.

Implement protection measures to reduce the risk of stand-replacing fire. Encourage ground-fires that keep regenerating ponderosa pine and Douglas-fir in check but do not kill mature trees.

Use prescribed burning to create semi-open parkland habitats with sufficient grassland understorey to provide habitat for an abundance of insects, and presence of some snags for nesting.

Information Needs

1. Impacts of tree encroachment into open ponderosa pine habitats, and the role of fire suppression.
2. Information on the effect of cattle grazing on habitat quality and the role that starlings play in Lewis's Woodpecker population levels.
3. Inventories in the Fraser River Basin and the Pavilion Ranges ecosections where populations are poorly documented.

Cross References

Bighorn Sheep, Fringed Myotis, "Great Basin" Gopher Snake, "Interior" Western Screech-Owl, Racer, White-headed Woodpecker, ponderosa pine/ bluebunch wheatgrass – silky lupine

References Cited

American Ornithologists' Union (AOU). 1983. Check-list of North American birds. 6th ed. Am. Ornith. Union. Baltimore, Md. 877 p.

Bent, A.C. 1939. Life histories of North American woodpeckers. U.S. Natl. Mus. Bull. 3.

Bock, C.E. 1970. The ecology and behaviour of the Lewis' Woodpecker (*Asyndesmus lewis*). Univ. Calif. Publ. Zool. 92:1–100.

B.C. Ministry of Environment, Lands and Parks (MELP). 1998. Habitat atlas for wildlife at risk: South Okanagan & Lower Similkameen. Penticton, B.C.

Campbell, R.W., N.K. Dawe, I. McTaggart-Cowan, J.M. Cooper, G.W. Kaiser, and M.C.E. McNall. 1990. The birds of British Columbia Vol. II: Nonpasserines. Diurnal birds of prey through woodpeckers. Royal B.C. Mus., Victoria, B.C., and Can. Wildl. Serv., Delta, B.C.

Cannings, R.A., R.J. Cannings, and S.G. Cannings. 1987. Birds of the Okanagan Valley, British Columbia. Royal B.C. Mus., Victoria, B.C.

Committee on the Status of Endangered Wildlife in Canada (COSEWIC). 2002. Canadian Species at Risk. www.speciesatrisk.gc.ca

Cooper, J.M. and S. Beauchesne. 2000. Inventory of Lewis' Woodpecker population and habitat in the east Kootenay. B.C. Min. Environ., Lands and Parks, Victoria, B.C. Wildl. Work. Rep. No. WR-100. 30 p.

Cooper, J.M. and C. Gilles. 2000. Breeding distribution of the Lewis's Woodpecker in the East Kootenay Trench in relation to fire history. *In* Proc. Conf. on the biology and management of species and habitats at risk. L.M. Darling (editor). Kamloops, B.C., Feb. 15–19, 1999. B.C. Min. Environ., Lands and Parks, Victoria, B.C., and Univ. Coll. Cariboo, Kamloops, B.C., pp. 423–428.

Cooper, J.M., C. Siddle, and G. Davidson. 1998. Status of the Lewis' Woodpecker in British Columbia. B.C. Min. Environ., Lands and Parks, Victoria, B.C. Wildl. Work. Rep. WR-91.

Covington, W.W. and M.M. Moore, 1994. Southwestern ponderosa forest structure. J. For. 92(1):39–47.

Currier, E.S. 1928. Lewis' Woodpeckers nesting in colonies. Condor 30:356.

Ehrlich, P.R., D.S. Dobkin, and D. Wheye. 1988. The birder's handbook: a field guide to the natural history of North American birds. Simon & Schuster Inc., Toronto, Ont.

Fraser, D.F., W.L. Harper, S.G. Cannings, and J.M. Cooper. 1999. Rare birds of British Columbia. B.C. Min. Environ., Lands and Parks, Wildl. Br. and Resour. Inventory Br., Victoria, B.C. 244 p.

Galen, C. 1989. A preliminary assessment of the status of the Lewis's Woodpecker in Wasco County, Oregon. Oreg. Dep. Fish Wildl. Tech. Rep. #88-3-01.

Godfrey, W.E. 1986. The birds of Canada. Revised ed. Natl. Mus. Can., Ottawa, Ont.

Hadow, H.H. 1973. Winter ecology of migrant and resident Lewis' Woodpeckers in southeastern Colorado. Condor 75:210–224.

Howell, S.N.G. and S. Webb. 1995. A guide to the birds of Mexico and northern Central America. Oxford Univ. Press, New York, N.Y.

Ingold, D.J. 1994. Influence of nest-site competition between European Starlings and woodpeckers. Wilson Bull. 109:227–241.

Linder, K.A. 1994. Habitat utilization and behavior of nesting Lewis' Woodpeckers (*Melanerpes lewis*) in the Laramie Range, southeast Wyoming. M.S. thesis. Univ. Wyoming, Laramie, Wyo.

Linder, K.A. and S.H. Anderson. 1998. Nesting habitat of Lewis' woodpeckers in southeastern Wyoming. J. Field Ornithol. 69(1):109–116.

National Geographic Society (NGS). 1999. Field guide to birds of North America. Washington, D.C.

NatureServe Explorer. 2002. An online encyclopaedia of life. Version 1.6. NatureServe. Arlington, VA. Available at http://www.natureserve.org/explorer/

Raphael, M.G. and M. White. 1984. Use of snags by cavity-nesting birds in the Sierra Nevada. Wildl. Monogr. 86. 66 p.

Saab, V.A. and J.G. Dudley. 1998. Responses of cavity-nesting birds to stand-replacement fire and salvage logging in ponderosa pine/Douglas-fir forests of southwestern Idaho. U.S. Dep. Agric., For Serv., Ogden, Utah. Res. Pap. RMRS-RP-11.

Sauer, J.R., J.E. Hines, I. Thomas, J. Fallon, and G. Gough. 2000. The North American breeding bird survey, results and analysis 1966–1999. Version 98.1. U.S. Geol. Surv., Patuxent Wildl. Res. Cent., Laurel, Md.

Sherwood, W.E. 1927. Feeding habits of the Lewis Woodpecker. Condor 29:171.

Short, L.L. 1982. Woodpeckers of the world. Delaware Mus. Nat. Hist., Greenville, Del.

Sorenson, E. 1986. A precipitous decline in Lewis' Woodpecker in Salt Lake and Davis Counties. Utah Birds 2:45–54.

Sousa, P.J. 1983. Habitat suitability index models: Lewis' Woodpecker. U.S. Fish Wildl. Serv., Washington, D.C. 14 p.

Thomas, J.W., R.G. Anderson, C. Maser, and E.L. Bull. 1979. Snags. *In* Wildlife habitats in managed forests: the Blue Mountains of Oregon and Washington. J.W. Thomas (editor). U.S. Dep. Agric. For. Serv., Agric. Handb. 553, pp. 60–77.

Tobalske, B.W. 1997. Lewis's Woodpecker (*Melanerpes lewis*). In The birds of North America, No. 284. A. Poole and F. Gill (editors). Acad. Nat. Sci., Philadelphia, Penn., and Am. Ornith. Union, Washington, D.C.

Vierling, K.T. 1997. Habitat selection of Lewis' Woodpecker in southeastern Colorado. Wilson Bull. 109:121–130.

_____. 1998. Interactions between European Starlings and Lewis' Woodpeckers at nest cavities. J. Field Ornith. 69(3):376–379.

Personal Communications

Beauchesne, S.M. 2002. Western Wildlife Research, Brentwood, B.C.

Ingham, L. 2001. Columbia Basin Fish and Wildlife Compensation Program, Nelson, B.C.

LONG-BILLED CURLEW

Numenius americanus

Original[1] prepared by I.A. (Penny) Ohanjanian

Species Information

Taxonomy

The Long-billed Curlew (*Numenius americanus*) is the largest member of the sandpiper family, Scolopacidae, to breed in British Columbia. Two subspecies are recognized by some researchers, the lesser Long-billed Curlew (*N. americanus parvus*) which nests in Canada and the northern United States, and the greater Long-billed Curlew (*N. americanus americanus*) which occurs farther south (Allen 1980; Cannings 1998). Genetic work has not yet been carried out to determine if this distinction is valid.

Description

The Long-billed Curlew is a large, long-legged shorebird found primarily in grassland habitats during the breeding season. It has mottled, light brown plumage, a buff-coloured breast, and cinnamon underwing linings. The bill is long and curves downwards, reaching a length of up to 195 mm in females and 140 mm in males (Jenni et al. 1982).

Distribution

Global

In the United States, Long-billed Curlews breed west of the Mississippi River in Washington, Oregon, northeastern California, Idaho, Nevada, central Utah, northern New Mexico, northern Texas, northwestern Oklahoma, Wyoming, Montana, Colorado, North Dakota, South Dakota, Nebraska, and western Kansas (Sauer et al. 2000). Since the early 1900s they have been extirpated from much of their historic range (Allen 1980; De Smet 1992). The major wintering areas for Long-billed Curlews are the coastal lowlands of California, the inland grasslands of the Central Valley, west Texas, eastern New Mexico, and along the Gulf coast in Texas and Louisiana (Sauer et al. 2000). De Smet (1992) has also reported this species wintering in the coastal lagoons of southern Mexico and south to Venezuela.

During the last century in Canada, curlew numbers have declined and the breeding range has shrunk. Formerly a breeder in southern Manitoba, the species is now listed as extirpated (De Smet 1992; Sauer et al. 2000). Long-billed Curlews remain in Saskatchewan (Smith 1996, cited by Hill 1998) but no longer occupy some of their historic range in the southeastern portions of the province (De Smet 1992). In Alberta, Long-billed Curlews breed in the southern half of the province, with the highest densities in the grasslands south of Red Deer (Hill 1998).

British Columbia

Non-breeding birds are widely distributed through the south-central Interior, north to the Nechako Lowland. This shorebird appears sporadically on the south coast during spring and autumn migration, where it is restricted to estuaries, mudflats, airports, or other open grassy areas.

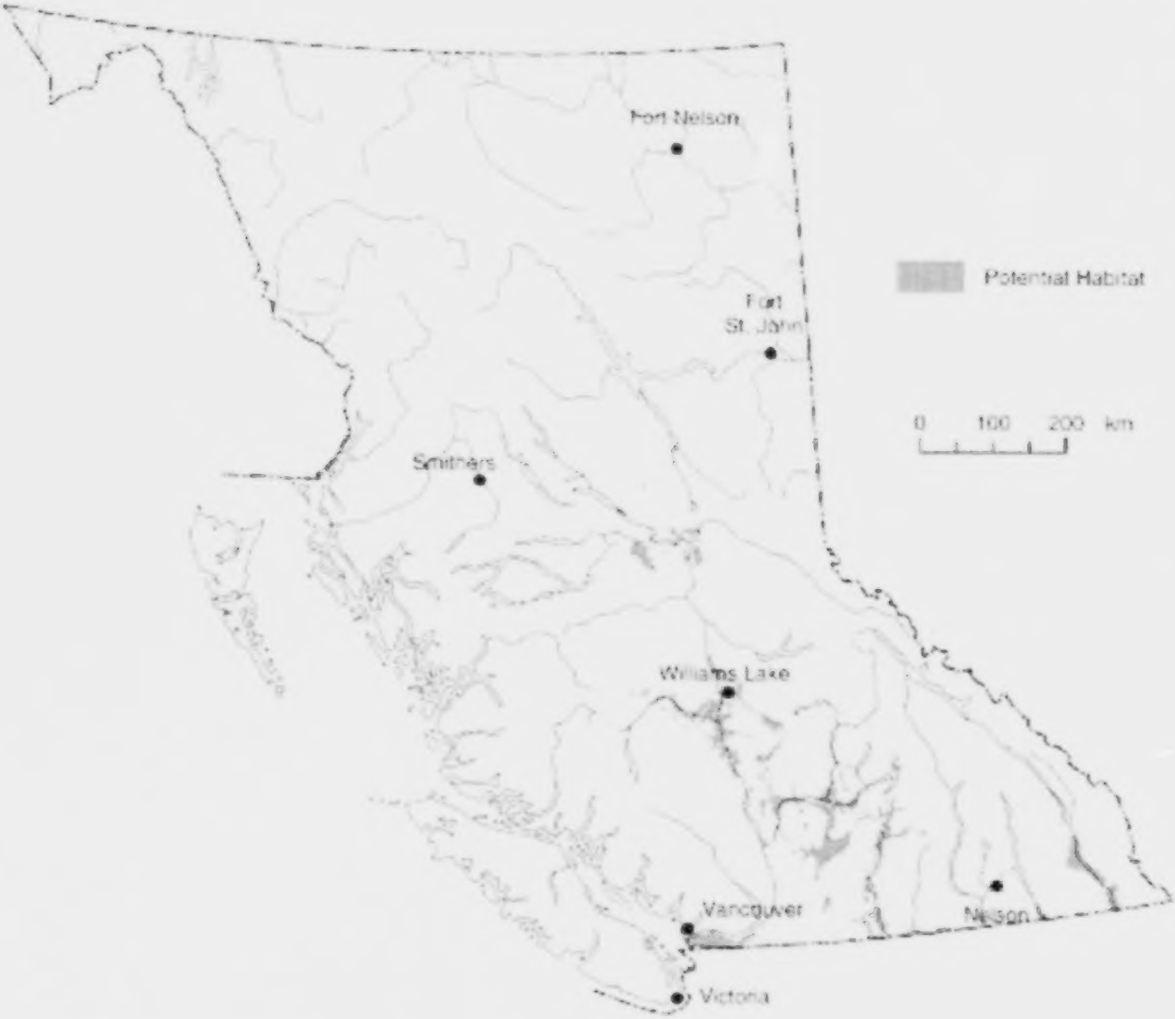
The Long-billed Curlew breeds in the southern Interior. Breeding areas are fairly disjunct and include areas from (1) Lillooet north to Quesnel (Chubb Lake), (2) the Chilcotin west to Alexis Creek, (3) the south Okanagan and lower Similkameen valleys, (4) the North Okanagan, (5) the Thompson-Nicola, and (6) the East Kootenay Trench (Cannings 1999). Small populations breed in agricultural cropland near McBride and in the Creston Valley (Van Damme 1996, cited by Cannings 1999). Records outside the periphery of its breeding range suggest that it may breed over a slightly larger range than currently documented. Breeding does not occur on the coast.

---

[1] Volume 1 account prepared by M. Sarell.

Long-billed Curlew

(Numenius americanus)


Fort Nelson
Fort St. John
Smithers
Williams Lake
Vancouver
Nelson
Victoria
▨ Potential Habitat
0 100 200 km

Note: This map represents a broad view of the distribution of potential habitat used by this species. The map is based on several ecosystem classifications (Ecoregion, Biogeoclimatic and Broad Ecosystem Inventory) as well as current knowledge of the species' habitat preferences. This species may or may not occur in all areas indicated. More detailed maps are available for this species from the Ministry of Sustainable Resource Management.

Forest region and districts

Coast:[2] Campbell River, Chilliwack

Northern Interior: Fort St. James (possible), Prince George, Vanderhoof

Southern Interior: 100 Mile House, Arrow Boundary, Cascades, Central Cariboo, Chilcotin, Headwaters, Kamloops, Kootenay Lake, Okanagan Shuswap, Quesnel, Rocky Mountain

Ecoprovinces and ecosections

CEI: CAB, CHP, FRB, QUL
COM: WIM
GED:[2] FRL, NAL
SBI: NEL
SIM: EKT, ELV, SCM, UCV, UFT
SOI: GUU, NIB, NOB, NOH, NTU, OKR, PAR, SHB, SOB, SOH, STU, THB

Biogeoclimatic units

BG: xh1, xh2, xh3, xw, xw1, xw2
CDF: mm
CWH: dm, vh1, vh2, vm1, xm1
ICH: xw
IDF: dk1, dk2, dk3, dk4, dm2, mw1, mw2, mw2a, xh1, xh1a, xh2, xh2a, xm, xw
PP: dh1, dh2, xh1, xh2, xh2a
SBS: dh, dw3, mk1

Broad ecosystem units

AB, BS, CF (in FRL only), DF, ES, ME, SS

Elevation

280–1220 m (Campbell et al. 1990; Fraser et al. 1999)

Life History

Diet and foraging behaviour

On the breeding grounds, adult Long-billed Curlews have been observed eating ground beetles (Allen 1980), and grasshoppers (Redmond and Jenni 1985) as well as earthworms in nearby irrigated hayfields (Ohanjanian 1985). Grasshoppers and beetles are the predominant prey of chicks, and caterpillars and spiders are also eaten (Redmond and Jenni 1985). In wintering habitats, the Long-billed Curlew feeds on mud crabs, fiddler crabs, ghost shrimps, and occasionally small fishes (De Graaf et al. 1991).

Reproduction

Long-billed Curlews first breed at 2–3 years (females) and 3–4 years (males) (Redmond and Jenni 1986). They nest in dry, open grasslands with low profile vegetation. Nests are shallow scrapes on the ground, from 130 to 275 mm in diameter and approximately 20 to 65 mm deep (Allen 1980). Nest cups may be lined with leaves, twigs, sheep or rabbit pellets, small stones, and grass (Allen 1980; Jenni et al. 1982). Four eggs are usually laid over 1 week (Jenni et al. 1982; Redmond 1984; Campbell et al. 1990). Clutches are initiated from mid-April until the first half of May, with most occurring in the third week of April (Redmond 1984; Cannings et al. 1987). More northerly birds may initiate clutches slightly later than those in the south, but it is unlikely that eggs are laid in any location after mid-May. Both adults share incubation (which takes about 28 days) (Allen 1980) and depend on their cryptic plumage to camouflage their presence. When incubating birds are flushed, they may take up to 1 hour to return to the nest (Allen 1980).

Chicks hatch synchronously, and adults and broods remain within 100–300 m of the nest site for the first few days (Jenni et al. 1982), after which time they become highly mobile. Some chicks become capable of flight at 35–40 days (Jenni et al. 1982), although Fitzner (1978) reports 40–45 days to fledging. Females usually depart from the breeding grounds prior to their chicks being fledged, leaving males to tend broods after the first few weeks (Redmond 1984; De Smet 1992). The young of birds that initiate clutches in the third week of April are generally fledged by the end of June. This date may extend into mid-July for later breeders.

Site fidelity

Both male and female Long-billed Curlews show strong site fidelity, returning each year to previous nesting territories (Redmond 1984). There is evidence that male curlews tend to return to their place of birth to set up a territory and attract a mate when they reach sexual maturity. Long-billed

---

[2] Non-breeding.

Curlews are monogamous and have long-term pair-bonds (Redmond 1984).

Home range

Nesting territory is highly variable in size. In the Chilcotin, nesting curlew densities ranged from a low of 0.73 pairs/100 ha of suitable habitat to 3.4 pairs/100 ha (Ohanjanian 1987). Hooper and Pitt (1996) found breeding densities ranged from 0.7 pair/100 ha to 2.1 pair/100 ha between 1987 and 1992. In the East Kootenay, densities at Skookumchuck ranged from 1 pair/20 ha (1985) to 1 pair/30 ha (Ohanjanian 1992). In southwestern Idaho estimates ranged from 1.74 males/100 ha suitable habitat to a maximum of 8.4 males/100 ha (Jenni et al. 1982). In southeastern Washington, breeding densities ranged from 1 pair/172.6 ha to 1 pair/66 ha in the densest area (Allen 1980). Broods require more space than nesting adults, and home ranges of up to 1000 ha are recorded in the literature (Jenni et al. 1982). Jenni et al. (1982) suggest that a curlew brood requires a minimum of 250 ha.

Movements and dispersal

Migrants appear from late March through early April during most years. Females may depart from the nesting areas as early as the latter half of June (Redmond 1984) with some males following soon after. Juveniles of the year remain the longest on the breeding grounds, forming feeding flocks and then departing at the end of July (Allen 1980; Redmond 1984).

Habitat

Structural stage

2: herb

Important habitats and habitat features

Nesting and brood rearing

Long-billed Curlews breed in areas with maximum visibility, largely because of co-operative anti-predator mobbing behaviours. They therefore need large contiguous openings of grassland and prefer areas that are gently sloping (Hooper and Pitt 1996). During pre-laying and incubation, areas with low vegetation (<10 cm tall preferred) and a maximum vertical coverage value of 40% at the height of a curlew's eyes (30 cm) are used preferentially (Allen 1980; Jenni et al. 1982; Ohanjanian 1992). During brood-rearing, higher vegetation (up to 30 cm) may be used, and irregular spacing of taller grass clumps complement chicks' cryptic colouration and provide hiding and shading opportunities for them (Allen 1980; Jenni et al. 1982). Mean width of openings used for nesting at Skookumchuck was 547 m (range 250–900) at the narrowest point (Ohanjanian 1992). A buffer of 300–500 m between nesting territories and non-suitable habitat or human activities has been observed by Bicak et al. (1982) and Jenni et al. (1982).

Use of new crested wheatgrass seedings has been documented in British Columbia, where a high proportion of native plant species were still present and the vegetative profile was low (Ohanjanian 1985). Such seedings will not continue to support the species if left ungrazed; in Idaho, they were avoided because their vertical coverage values were too high (Jenni et al. 1982).

Migration

This shorebird appears sporadically on the south coast during spring and autumn migration, where it is restricted to estuaries, mudflats, airports, or other open grassy areas (Campbell et al. 1990).

Foraging

Insects are obtained primarily on the grasslands. Curlews may be seen soon after their arrival in spring, however, earthworms provide immediate, high quality protein in irrigated hayfields (Ohanjanian 1985).

Conservation and Management

Status

The Long-billed Curlew is on the provincial *Blue List* in British Columbia. It is designated as a species of *Special Concern* in Canada (COSEWIC 2002).

Summary of ABI status in BC and adjacent jurisdictions (NatureServe Explorer 2002)

BC	AB	ID	MT	OR	WA	Canada	Global
S3B, SZN	S3B	S3B, SZN	S4B, SZN	S3S4	S2B, S2N	N4B	G5

Trends

Population trends

The population of Long-billed Curlews in the North Okanagan Valley declined considerably between 1982 and 1995 (Cannings et al. 1987; Cannings 1999). The south Okanagan birds appear to fluctuate, and may have done so historically as well (Cannings 1999). The East Kootenay population has increased since the 1970s (Ohanjanian 1992), and new reports of birds at Creston (Van Damme 1996, cited by Cannings1999) suggest that they may be expanding their range in this region. There is no hard data on current population trends elsewhere in British Columbia. The overall population appears to be stable, with some areas increasing and other decreasing (Cannings 1999).

Habitat trends

Habitat continues to be lost due to forest encroachment, subdivisions, and conversion of rangelands to agricultural use.

Threats

Population threats

In British Columbia, the Long-billed Curlew has a restricted breeding distribution and small population size. Cannings (1999) estimated a minimum population of about 250 breeding pairs. The Long-billed Curlew is a ground-nesting species and therefore experiences high rates of predation on eggs and young. Predators of nests or chicks include coyotes, weasels, badgers, magpies, ravens, dogs, and snakes (Allen 1980; Redmond 1984). If nests are predated, adults do not usually re-nest (Cannings 1999).

Habitat threats

Major threats to Long-billed Curlew habitat are urbanization, forest encroachment due to fire suppression, noxious weeds, and conversion of native rangelands to agricultural crops such as ginseng and hay (Ohanjanian 1992; Cannings 1999). Hay fields are generally too dense for small chicks to move about in. There are reports of Long-billed Curlews nesting in grain fields (Cannings 1999); their productivity in these habitats, however, has not been ascertained. Cheatgrass (*Bromus tectorum*), an introduced invasive grass, is tolerated and may even be preferred by Long-billed Curlews but other invasive species, particularly knapweed, are thought to be avoided by curlews.

All-terrain vehicles (ATVs) may pose a serious threat in localized areas. Range quality may become degraded as ATV tracks destroy vegetation and facilitate topsoil erosion. ATVs may also cause direct mortality to Long-billed Curlews in several ways: eggs may become overheated leading to heat stress and embryo death while adults are flushed off nests, predators such as ravens may be attracted to chicks by adult alarm calls while they mob human intruders, and nests or chicks may be run over.

Although Long-billed Curlews tolerate and may even benefit from livestock grazing, they may be impacted (e.g., trampling) or disturbed by heavy livestock during critical times during the breeding season.

Pesticides, particularly organochlorines, may also impact curlew breeding success.

Legal Protection and Habitat Conservation

The Long-billed Curlew, its nests, and its eggs are protected under the federal *Migratory Birds Convention Act* and the provincial *Wildlife Act*.

For the most part, very little of known curlew nesting habitat is protected. Cannings (1999) estimates that <10% of curlews nest within lands protected for conservation. In the south Okanagan and Similkameen, only 6% of curlew habitat is considered to be within lands designated for conservation purposes and 47% is within private land (MELP 1998). In the Cariboo/Chilcotin, some protection is available for a few pairs of Long-billed Curlews at the Junction Provincial Park (410 ha) (Ohanjanian 1987; T. Hooper, pers. comm.). There are also a few pairs in the south Okanagan Wildlife Management Area and at White Lake, which is under long-term lease to Nature Trust (Cannings 1999). In the East Kootenay, one or two pairs nest on properties owned by the province at Bummer's Flats and on Wolf Creek Road. Churn Creek and Lac du Bois may also contain nesting curlews.

Under the results based code, range use plans that consider the requirements of this species may be sufficient to meet the needs of the species. However for a species to be specifically addressed within these plans they must be designated as Identified Wildlife. In some cases, current grazing practices may be adequate to maintain habitats for this species and therefore it may not be necessary to establish a WHA. This assessment must be made case by case.

Identified Wildlife Provisions

Wildlife habitat area

Goals

Maintain suitable nesting and brood rearing habitat for multiple pairs.

Feature

Establish WHAs over breeding areas occupied by multiple pairs. Breeding areas include nesting, incubation, and brood rearing habitats.

Size

Typically between 250 and 500 ha but will ultimately depend on the number of pairs and area of suitable habitat. Larger contiguous openings will support more curlews (denser numbers) than smaller areas (Bicak et al. 1982).

Design

The WHA should include flat to moderately rolling terrain and short grass cover (ideally ≤10 cm tall during the pre-laying period and up to 25 cm during brood-rearing) (Jenni et al. 1982). Ideally the WHA should include as large an area of grassland as possible but should include ~250 ha of brood rearing habitat with scattered clumps of grasses 20–30 cm in height (this may include the nesting territory). The WHA should be at least 250 m wide at its narrowest point but should include a 500 m buffer of similar open habitat (Jenni et al. 1982) to protect against disturbance. The buffer should be managed similar to the core so does not need to be distinguished but should be considered when designing WHA boundaries.

General wildlife measures

Goals

1. Provide low profile vegetation (<10 cm) for nesting in April.
2. Provide vegetation that is approximately 25 cm in height for brood rearing in May.
3. Minimize disturbance from humans or livestock during critical times throughout the breeding season (1 April to 15 July).
4. Maintain native bunchgrass in brood-rearing areas.
5. Minimize forest encroachment.

Measures

Access

- Do not construct roads unless there is no other practicable option.
- Limit road use during critical times during the breeding season (1 April to 15 July) when considered necessary by statutory decision maker. Contact MWLAP staff for site-specific times.

Pesticides

- Do not use pesticides.

Range

- Control timing and distribution of livestock grazing to avoid disturbances during the breeding season. Consult MWLAP for site-specific times.
- Plan livestock grazing to maintain grass cover in nesting areas that is on average <10 cm in height when curlews return in spring.
- Avoid concentrating livestock during the breeding season (1 April to 15 July) particularly during the incubation period. Place salt and water troughs in treed areas wherever possible to prevent livestock concentrations in the open where nests may occur. When it is necessary to move livestock through a WHA during the incubation period (generally 15 April to 31 May) and there is no other practicable option, use forest or shrub areas or areas immediately adjacent to trees (<20 m) rather than in the middle of openings. Consult MWLAP for specific times.
- Do not use fire in nesting areas during egg-laying or brood-rearing times.

Recreation

- Do not establish recreational trails.

Additional Management Considerations

Prevent or restrict motorized recreation vehicles such as ATVs and dirt bikes within WHA particularly between 15 March to 15 July.

Where appropriate, and the habitat capability is high, revegetate crested wheatgrass seedings to native grass species.

Control forest encroachment using logging in combination with burning or other suitable methods.

Information Needs

1. Population size and trend.
2. Determine if Long-billed Curlews breed in Churn Creek Protected Area.
3. Research on brood rearing and rearing habitat requirements is needed.

Cross References

Grasshopper Sparrow, Sage Thrasher

References Cited

Allen, J.N. 1980. The ecology and behaviour of the long-billed curlew in southeastern Washington. Wildl. Monogr. 73. 67 p.

Bicak, T.K., R.L. Redmond, and D.A. Jenni. 1982. Effects of grazing on long-billed curlew breeding behaviour and ecology in southwestern Idaho. *In* Proc. Symp. on wildlife livestock relationships. J.M. Peek and P.D. Dalke (editors). Univ. Idaho, For., Wildl. Range Exp. Stn., Moscow, Idaho, pp. 74–85.

B.C. Ministry of Environment, Lands and Parks (MELP). 1998. Habitat atlas for wildlife at risk: South Okanagan and Lower Similkameen. Penticton, B.C.

Campbell, R.W., N.K. Dawe, I. McTaggart-Cowan, J.M. Cooper, G.W. Kaiser, and M.C.E. McNall. 1990. The birds of British Columbia. Vol. II: Nonpasserines. Diurnal birds of prey through woodpeckers. Royal B.C. Mus., Victoria, B.C., and Can. Wildl. Serv., Delta, B.C. 636 p.

Cannings, R.A., R.J. Cannings, and S.G. Cannings. 1987. Birds of the Okanagan Valley, British Columbia. Royal B.C. Mus., Victoria, B.C. 420 p.

Cannings, R.J. 1998. The birds of British Columbia: a taxonomic catalogue. B.C. Min. Environ., Lands and Parks, Victoria, B.C. Wildl. Bull. B-86.

______. 1999. Status of the Long-billed Curlew in British Columbia. B.C. Min. Environ., Lands and Parks, Wildl. Br., Victoria, B.C. Wildl. Work. Rep. WR-96.

Committee on the Status of Endangered Wildlife in Canada (COSEWIC). 2002. Canadian Species at Risk. www.speciesatrisk.gc.ca

DeGraaf, R.M., V.E. Scott, R.H. Hamre, L. Ernst, and S.H. Anderson. 1991. Forest and rangeland birds of the United States natural history and habitat use. U.S. Dep. Aric. For. Serv., Agric. Handb. 688. Northern Prairie Wildl. Res. Cent. Home Page http://www.npwrc usgs.gov/resource/1998/forest/forest.htm (Version 03NOV98).

De Smet, K.D. 1992. Status report on the long-billed curlew (*Numenius americanus*) in Canada. Dep. Nat. Resour., Winnipeg, Man.

Fitzner, J.N. 1978. The ecology and behavior of the Long-billed Curlew (*Numenius americanus*) in southeastern Washington. Ph.D. thesis. Washington State Univ., Pullman, Wash.

Fraser, D.F., W.L. Harper, S.G. Cannings, and J.M. Cooper. 1999. Rare birds of British Columbia. B.C. Min. Environ., Lands and Parks, Wildl. Br., and Resour. Inventory Br., Victoria, B.C.

Hill, D.P. 1998. Status of the Long-billed Curlew (*Numenius americanus*) in Alberta. Alberta Environ. Prot., Fish. Wildl. Manage. Div., and Alberta Conserv. Assoc., Edmonton, Alta. Wildl. Status Rep. 6. 20 p.

Hooper, T.D. and M.D. Pitt. 1996. Breeding bird communities and habitat associations in the grasslands of the Chilcotin region, British Columbia. Environ. Can., Can. For. Serv., and B.C. Min. For., Victoria, B.C. FRDA Rep. No. 243.

Jenni, D.A., R.L. Redmond, and T.K. Bicak. 1982. Behavioral ecology and habitat relationships of Long-billed Curlews in western Idaho. Report to Bur. Land Manage., Boise, Idaho. 234 p

Ohanjanian, I.A. 1985. The Long-billed Curlew (*Numenius americanus*) on Skookumchuck Prairie – status report and enhancement plan. B.C. Min. Environ., Wildl. Br., Cranbrook, B.C.

______. 1987. Status report and management recommendations for the Long-billed Curlew (*Numenius americanus*) on the Junction. Report for B.C. Min. Environ., Wildl. Br., Cariboo/Chilcotin Reg. BC. 25 p.

______. 1992. Numbers, distribution and habitat dynamics of Long-billed Curlews in the East Kootenay. B.C. Min. Environ., Wildl. Br., Cranbrook, B.C. 41 p

NatureServe Explorer. 2002. An online encyclopaedia of life. Version 1.6. NatureServe. Arlington, VA. Available at http://www.natureserve.org/explorer/

Redmond, R.L. 1984. The behavioral ecology of Long-billed Curlews (*Numenius americanus*) breeding in western Idaho. Ph.D. thesis. Univ. Mont., Missoula, Mont. 140 p.

Redmond, R.L. and D.A. Jenni. 1985. Note on the diet of Long-billed Curlew chicks in western Idaho. Great Basin Nat. 45:85–86.

______. 1986. Population ecology of the Long-billed Curlew (*Numenius americanus*) in western Idaho. Auk 103:755–767.

Sauer, J.R., J.E. Hines, I. Thomas, J. Fallon, and G. Gough. 2000. The North American breeding bird survey, results and analysis 1966–1999. Version 98.1. Patuxent Wildl. Res. Cent., Laurel, Md. Most recent update: 22 August 2000.

Smith, A.R. 1996. Atlas of Saskatchewan birds. Saskatchewan Natural History Society, Regina, SK. Spec. Publ. No. 22. 456 pp.

Van Damme, L.M. 1996. Creston Valley: Checklist of birds. Nelson Nat., Nelson, B.C.

Personal Communications

Hooper, T.C. 2001. Consultant, Victoria, B.C.

MARBLED MURRELET

Brachyramphus marmoratus

Original[1] prepared by Alan Burger

Species Information

Taxonomy

The Marbled Murrelet, *Brachyramphus marmoratus,* is a member of the auk family (Alcidae). No subspecies are recognized in North America (AOU 1997). Some intraspecific morphological and molecular variation has been found among populations of Marbled Murrelets (reviewed in Burger 2002). The small population in the western Aleutian Islands, Alaska, shows some genetic differences from the rest of the North American population, but samples from British Columbia, southeastern Alaska, Washington, and Oregon showed no consistent genetic differences or evidence of subspecies.

Description

Small seabird (length 24–25 cm; mass 190–270 g; Nelson 1997). There is no sexual size or colour dimorphism. Adults in breeding plumage have a marbled grey-brown plumage that provides good camouflage at nest sites. The non-breeding (basic) and juvenile plumages are black and white, typical of most seabirds.

Marbled Murrelets forage by diving, using its wings for underwater propulsion (Gaston and Jones 1998). Adaptations for this mode of foraging include increased flight muscles and reduced wing area, resulting in high wing-loading. The consequences are that Marbled Murrelets need to fly fast (generally more than 70 km/h), are not very maneuvrable in flight, and have difficulty landing and taking off. This in turn affects their choice of nest site and vulnerability to terrestrial predators (details below).

Distribution

Global

The Marbled Murrelet occurs from the Aleutian Islands, Alaska, along the southern coast of Alaska south to central California.

British Columbia

Murrelets are likely to be found anywhere along the coast of British Columbia within 30 km of the Pacific coast. A few birds venture farther inland, up to 80 km from the coast. At sea, they tend to remain within sheltered waters or within 500 m of exposed open coasts.

Forest regions and districts

Coast: Campbell River, Chilliwack, North Coast, North Island, Queen Charlotte Islands, South Island, Squamish, Sunshine Coast

Northern Interior: Kalum, Skeena Stikine

Ecoprovinces and ecosections

Terrestrial:

COM: CBR, EPR, HEL, KIR, MEM, NAB, NAR, NBR, NIM, NPR, NWC, NWL, OUF, QCL, SBR, SKP, SPR, WQC, WIM

GED: FRL, GEL, LIM, NAL, SGI, SOG

Marine:

COM: DIE, HES, QCS, QCT, VIS

GED: JDF

Biogeoclimatic units

CDF, CWH, MH

Broad ecosystem units

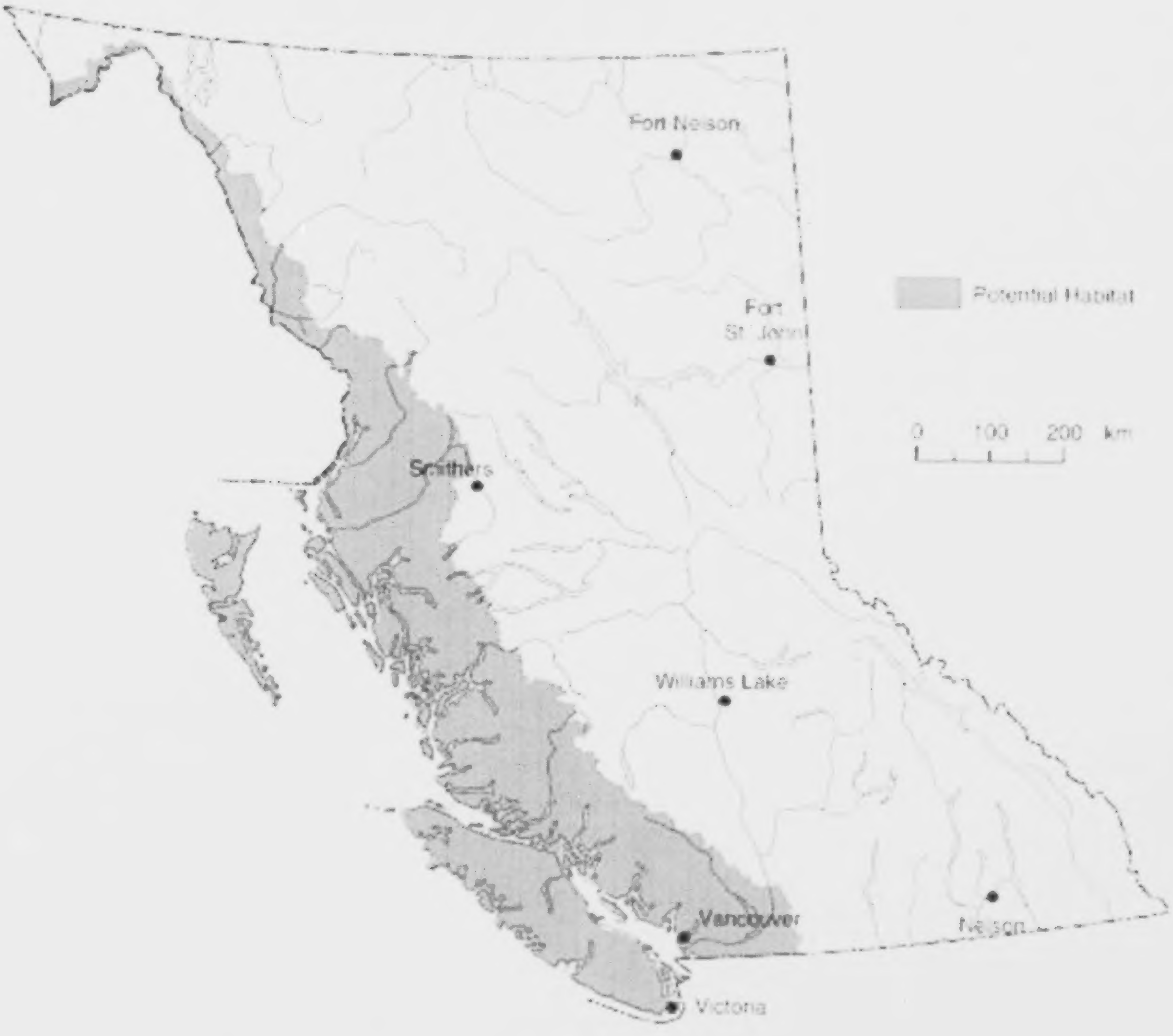
Terrestrial:

CD, CG, CH, CP, CS, CW, DA, FR, HB, HL, HS, MF, RR, SR, YM

---

[1] Volume 1 account prepared by A. Derocher and others.

Marbled Murrelet
(Brachyramphus marmoratus)


Fort Nelson
Fort St. John
Potential Habitat
0 100 200 km
Smithers
Williams Lake
Vancouver
Nelson
Victoria

Note: This map represents a broad view of the distribution of potential habitat used by this species. The map is based on several ecosystem classifications (Ecoregion, Biogeoclimatic and Broad Ecosystem Inventory) as well as current knowledge of the species' habitat preferences. This species may or may not occur in all areas indicated. More detailed maps are available for this species from the Ministry of Sustainable Resource Management.

Aquatic:
ES, IM, LL, LS

Elevation

0–~1500 m (but see "Habitat" below for preferred elevations)

Life History

Diet and foraging behaviour

Murrelets eat small schooling fish (predominantly Pacific Sand Lance *Ammodytes hexapterus*, and immature Pacific Herring *Clupea harengus*), and large pelagic crustaceans (euphausiids, mysids, amphipods) (Burger 2002). In many areas the distribution, abundance, and movements of murrelets at sea seem closely linked to those of sand lance, especially during the murrelet's breeding season.

The Marbled Murrelet forages by diving, using its wings for underwater propulsion. Adaptations for this mode of foraging include increased flight muscles and reduced wing area (Gaston and Jones 1998). Most murrelets forage in relatively shallow water (<30 m deep), either in sheltered sea or within 500 m of exposed shores. They tend to avoid the centres of deep fjords and channels. Adults eat a range of prey types, but select a larger fish (e.g., mature sand lance) to carry back to the nestling. Proximity to good foraging sites is likely to influence selection of inland nest sites. Most nests were within 50 km of foraging sites, although breeding murrelets are known to commute 100 km or more to feed at prey concentrations (Whitworth et al. 2000; Hull et al. 2001; Burger 2002).

Reproduction

Reproduction and demography are reviewed in Ralph et al. (editors, 1995), Nelson (1997), and Burger (2002). Breeding probably begins at age 2–5 years, and the generation time was estimated to be about 10 years. Estimates of the proportion of mature adults in the population range from 55 to 95%, and are more likely near the upper part of this range. In common with most seabirds, murrelets have low reproductive recruitment (fecundity), balanced by high adult survival. Fecundity (number of female fledglings raised per female of breeding age) ranged from 0.17 to 0.22 from studies of nesting success and radio-telemetry, and was 0.13 based on adjusted counts of juveniles and adults at sea. Mark-recapture studies in Desolation Sound indicate local annual adult survival of 0.83–0.92 (Cam et al., in press).

The breeding season is prolonged (late-April through early September) and some failed breeders may lay a replacement egg (McFarlane Tranquilla 2001; Lougheed et al. 2002b). Most nests are on platforms (limbs or deformities >15 cm diameter) in old conifers (details below), but a few are on mossy cliff-ledges and one has been found in a deciduous tree (Burger 2002). The nest is a simple depression in the moss or duff. The clutch is a single egg. Both sexes incubate the egg and feed the chick. The incubation period is ~30 days and chicks fledge when 30–40 days old. Adults exchange incubation shifts and deliver most meals to the chick in dark twilight before dawn. Some meals are also delivered at dusk and a few in daylight hours. Chicks fledge by flying to the sea and are not attended by parents after fledging.

Site fidelity

Site fidelity is not well known, but evidence suggests that suitable stands will be repeatedly used for nesting (Manley 1999; Burger 2002; Simon Fraser Univ., unpubl. data). Nests and nest trees are generally not re-used in subsequent seasons, but a few radio-tagged birds returned to nest in different trees within the same stand. A few trees have been found with more than one nest from different seasons. One banded bird that bred in Desolation Sound, British Columbia, wintered in the San Juan Islands, Washington, but was re-captured in Desolation Sound in the following breeding season (Beauchamp et al. 1999). Watersheds generally support similar numbers of murrelets from year to year, but there might be some interannual movement by murrelets among adjacent watersheds (Burger 2001, 2002).

Home range

Most nests in British Columbia were within 30–50 km of marine capture sites (for radio-telemetry studies) and foraging aggregations (reviewed by Burger 2002). In some situations, such as nest sites inland of long, deep fjords, murrelets commute large distances (occasionally >100 km) to feed at prey concentrations. Murrelets show diurnal and seasonal movements among foraging sites, but often aggregate predictably at favoured sites. Unlike most other seabirds, murrelets are not colonial; nest sites appear to be scattered across suitable forest habitat. Some individuals breeding on Vancouver Island foraged in both Clayoquot Sound and the Strait of Georgia within the same season (Simon Fraser Univ., unpubl. data).

Movement and dispersal

Marbled Murrelets are somewhat migratory, and in many parts of British Columbia both adults and newly fledged juveniles tend to move away from breeding grounds at the end of the breeding season, from late July through September (Burger 2002; Lougheed et al. 2002a). A portion of the population often remains near the breeding grounds through winter. Beauchamp et al. (1999) provided the only proof of migration, between Desolation Sound and the San Juan Islands, Washington (see previous section). Other marked murrelets from Desolation Sound, however, seemed to remain there after breeding (Beauchamp et al. 1999). Migration between the breeding areas on the outer west coast of Vancouver Island to more sheltered wintering areas in the Strait of Georgia and Puget Sound seems to occur (Burger 2002).

Habitat

Structural stage

7: old forest (>250 yr – age class 9, but 8 is acceptable if older forest is not present and the age class 8 provides platform limbs and other nest attributes; see Tables 1 and 3 below).

Important habitats and habitat features

Nesting

In the *Conservation Assessment of Marbled Murrelets in British Columbia: A Review of the Biology, Populations, Habitat Associations, and Conservation*, suitable nesting habitat is defined as the habitat in which Marbled Murrelets nesting in British Columbia are likely to nest successfully. In general, suitable habitat is old seral stage coniferous forest, providing large trees with suitable platforms (limbs or deformities >15 cm diameter), and a variable canopy structure allowing access to the platforms. More detailed descriptions of the tree and stand attributes are given below. Some Marbled Murrelet nests in British Columbia have been found in habitat that differs somewhat from the defined suitable habitat (e.g., cliffs, a deciduous tree, isolated veterans in stunted stands), but inclusion of all the possible habitat types likely to be used by murrelets becomes unworkable. This account focuses on forest habitat most likely to be occupied by nesting murrelets.

Over 200 nests have been found in British Columbia, with the vast majority in old conifers (Nelson 1997; Burger 2002; Simon Fraser Univ., unpubl. data). About 3% of nests found in Desolation Sound were on mossy cliff-ledges (Bradley and Cooke 2001), and similar sites have been found near Clayoquot Sound. One Desolation Sound nest was in a large red alder (*Alnus rubra*) (Bradley and Cooke 2001). Most B.C. nests were found in yellow-cedar (*Chamaecyparis nootkatensis*), western hemlock (*Tsuga heterophylla*), Sitka spruce (*Picea sitchensis*), Douglas-fir (*Pseudotsuga menziesii*), and western redcedar (*Thuja plicata*), with fewer in mountain hemlock (*Tsuga mertensiana*) and amabilis fir (*Abies amabilis*) (Burger 2002). It is unlikely that murrelets select particular tree species, but certain species are more likely to provide large horizontal platforms suitable for nesting, and this varies regionally and with elevation.

Microhabitat requirements for Marbled Murrelet nest sites are summarized in Table 1. The first four conditions are commonly found in dominant old forest trees which explains the overwhelming majority of nests in such trees. Most nest trees in

British Columbia were >200 years old (Burger 2002). In Oregon, a few nests have been found in younger western hemlock trees deformed by mistletoe (Nelson 1997), but no nests have been found in such sites in British Columbia.

Two studies in British Columbia compared forest patches containing nests with adjacent randomly selected patches. Manley (1999) found that nest patches had significantly more large trees (>60 cm diameter) and more trees with platforms (limbs with diameter >15 cm including epiphytes) than random patches. Waterhouse et al. (2002) found that forest polygons with murrelet nests were significantly older, and had taller trees, larger mean basal area, and greater vertical complexity than adjacent randomly selected treed polygons. Numerous other studies involving audiovisual surveys, vegetation analysis, tree climbing, and radio-telemetry have confirmed the association of nesting murrelets with a combination of large old trees, availability of large moss-covered limbs providing nest platforms, and variable canopy structure with gaps providing access to the platform limbs (Burger 2002).

In British Columbia, murrelet nests have been found from sea level to about 1500 m in elevation (Nelson 1997; Burger 2002). Among 138 nests found by telemetry in British Columbia, 84% were found below 1000 m, and there was a rapid drop-off in nests with increasing elevation above 1000 m (Burger 2002; Simon Fraser Univ., unpubl. data). Where low elevation forests with suitable nesting habitat were still plentiful, 64% of nests were below 600 m, and 93% were below 900 m (*n* = 55 telemetry nests). In Desolation Sound nesting success increased with increasing elevation, which was probably due to reduced densities of predators at higher elevations (Bradley 2002). There are no comparative studies of nest success versus elevation from elsewhere. In contrast, audiovisual surveys showed declining evidence of stand occupancy by murrelets with increasing elevation, and stand level and micro-habitat features important for nesting (e.g., large trees, presence of potential platform limbs, and epiphyte cover on branches) usually declined with increasing elevation (Burger 2002). In general, preferred nesting habitat in British Columbia is likely to be found at 0–900 m elevation

Table 1. Key microhabitat characteristics for Marbled Murrelets nest site in British Columbia (for more details see Hamer and Nelson 1995; Nelson 1997; Burger 2002)

Murrelet requirements	Key habitat attributes
Sufficient height to allow stall-landings and jump-off departures	Nest trees are typically >40 m tall (range 15–80 m), and nest heights are typically >30 m (range 11–54 m); nest trees are often larger than the stand average.
Openings in the canopy for unobstructed flight access	Small gaps in the canopy are typically found next to nest trees, and vertical complexity of the canopy is higher in stands with nests than in other nearby stands.
Sufficient platform diameter to provide a nest site and landing pad	Nests are typically on large branches or branches with deformities, usually with added moss cover; nest limbs range from 15 to 74 cm in diameter; nests typically located within 1 m of the vertical tree trunk.
Soft substrate to provide a nest cup	Moss and other epiphytes provide thick pads at most nest sites, but duff and leaf litter are used in drier areas.
Overhead cover to provide shelter and reduce detection by predators	Most nests are overhung by branches.

(perhaps 0–600 m in watersheds with more intact old stands), with less suitable conditions at 900–1500 m, and areas above 1500 m are unlikely to be used. In all cases elevation should not be the sole criterion for establishing suitability, and evidence of nesting, occupancy, and/or suitable habitat (e.g., potential nest platforms) is needed for establishing habitat suitability.

Marbled Murrelets readily nest on steep slopes, and many nests found with telemetry were on steep slopes (30–70°) (Burger 2002; Simon Fraser Univ., unpubl. data). In Desolation Sound, nest success was positively correlated with slope (Bradley 2002). Slopes appear to enhance access to nest sites in tree canopies and perhaps reduce predation risk.

Steep slopes are not essential for nesting if forest canopies are non-uniform with small gaps, as typically found in old forest stands. Several studies showed negative or neutral effects of slope on rates of occupied detections and measures of nest habitat quality (Burger 2002). Slope should be treated as a neutral variable in habitat management; suitable habitat is selected regardless of slope. Aspect does not appear to have a strong effect on the placement or success of nests, although south-facing slopes in drier areas appear to have fewer mossy platforms than other aspects (Burger 2002).

Foraging

Marbled Murrelets forage at sea. Important habitats include shallow nearshore and sheltered waters, especially those known to support foraging aggregations, concentrations of prey schools, or marine habitats likely to support prey (e.g., the sand and gravel subtidal substrates in which sand lance bury themselves). It is important to maintain inland breeding habitat associated with known concentrations of murrelets at sea (MMRT 2003).

Wintering

Marbled Murrelets winter at sea. Important habitats are as described for foraging, but are generally more sheltered than those used in summer.

Conservation and Management

Status

The Marbled Murrelet is on the *Red List* in British Columbia. It is designated as *Threatened* in Canada (COSEWIC 2002).

Summary of ABI status in BC and adjacent jurisdictions (NatureServe Explorer 2002)

AK	BC	CA	OR	WA	Canada	Global
S2S3	S2B, S4N	S1	S2	S3	N2	G3G4

Trends

Population trends

The population in 2002 was estimated to be 54 700–77 700 birds of all ages (median 66 000 birds, or 56 000 adults if 85% are mature adults) based on extrapolations from radar and at-sea counts (Burger 2002). Large parts of the range have no counts and there is considerable uncertainty around these population estimates. There are few long-term data to assess population trends, but most data and anecdotal accounts indicate declining populations in some parts of British Columbia, especially in eastern Vancouver Island and the southern mainland (Burger 2002). At-sea surveys in Clayoquot and Barkley sounds on the west of Vancouver Island indicate declines of 20–40% between 1979 and1982 and the mid-1990s, but these trends are complicated by negative responses by murrelets to unusually warm oceans in the 1990s and by the variability in at-sea census data (Burger 2002).

Habitat trends

Accurate assessments of the amount of nesting habitat lost to industrial logging are not yet available, because of the difficulties in defining suitable habitat and mapping such habitat across coastal British Columbia. Preliminary mapping by the B.C. Ministry of Forests and by Demarchi and Button

(2001a, 2001b; see Burger 2002) suggests that the amount of potential (capable) murrelet habitat lost by 2000, since the onset of industrial logging, was in the order of 35–49%. Large declines in capable habitat were evident in the following former forest districts: Port Alberni, Campbell River, Duncan, Port McNeill, and Sunshine Coast (Demarchi and Button 2001a, 2001b). The reduction of habitat within the Georgia Depression (southeast Vancouver Island and the southern mainland) is of particular concern (Kaiser et al. 1994; MMRT 2003).

Threats

Population threats

Demographic models indicate that murrelet populations are most sensitive to adult survival, followed by survival of immatures and then fecundity (Beissinger and Nur 1997; Cam et al., in press). The most likely direct threats to adults are from oil spills and entanglement in fishing gear (Burger 2002). Predation of adults (at sea and inland) and disturbance at foraging areas due to boat traffic and aquaculture have also been identified as threats, but their effects are not known (Burger 2002).

Habitat threats

Reduced recruitment due to loss of nesting habitat is widely accepted as the major threat throughout the species' range (Ralph et al. 1995; Nelson 1997; Hull 1999). Radar studies in five regions of British Columbia show significant correlations between numbers of murrelets and existing areas of apparently suitable nesting habitat (Burger 2002). In addition, a radar study in Clayoquot Sound showed reduced populations in watersheds subjected to intensive logging and concluded that murrelets did not pack into remaining old forest patches in higher densities (Burger 2001). For these reasons, breeding populations of murrelets are expected to decline as areas of suitable nesting habitat decrease. The effects on murrelets of habitat fragmentation and creation of forest edges by clearcut logging are less clear.

Populations of murrelets seem more dependent on the area and quality of available nesting habitat than on the size and shape of habitat patches and edge-effects. Risk modelling suggested that edge effects were clearly secondary (but not trivial) to amount and quality of nesting habitat in determining population persistence in British Columbia (Steventon et al., in press). The effects of small patches, forest edges, and fragmentation of habitat on nesting Marbled Murrelets are still unclear, and field data are somewhat contradictory (Burger 2002). Reduced nest success within 50 m of forest edges, attributed to increased predation risk, was reported in one range-wide review (Manley and Nelson 1999). In contrast, nests in Desolation Sound located by telemetry showed no difference in success between edge and interior sites, perhaps because nests proximal to edges predominated at higher altitudes where predation was less prevalent (Bradley 2002). Some common nest predators, such as Steller's Jay (*Cyanocitta stelleri*), favour forest edges bordering clearcuts and roads (Masselink 2001), but a comprehensive study on the Olympic Peninsula, Washington, showed that many potential predators of murrelet nests were not edge-loving species and that other factors affected predation risk, notably proximity to human activities (attracting corvids) and successional stage of vegetation bordering old forest edges (Raphael et al. 2002). Loss of habitat through windthrow along forest edges and roads, and changes to canopy microclimates near forest edges are also likely (Burger 2002). Altered microclimates might affect nesting murrelets directly through thermal stress, or indirectly through removal or inhibition of epiphyte mats used as nest substrates, but there are no field data to test these hypotheses. Edge effects are most likely to occur at "hard" edges, defined as old forest (>250 yr) bordered by clearcuts or young regenerating forest <40 years old, and any negative effects are likely to be greatest within 50 m of such edges (Burger 2002).

The effects of roads on murrelets and their nesting habitat have not been fully investigated. Roads potentially create both benefits (enhanced access to canopy platforms) and risks (attracting predators such as ravens and jays, increasing windthrow, and altering canopy microclimates).

Five radar studies in British Columbia and one on the Olympic Peninsula, Washington, showed significant positive correlations between numbers of murrelets and areas of large-tree old seral habitat per watershed (Burger 2002). These data indicate that watershed populations of Marbled Murrelets are directly proportional to the areas of nesting habitat available. Densities (murrelets per area of habitat) were significantly higher on the west coast of Vancouver Island (0.082 ± 0.034 SD birds per ha) than on the B.C. mainland coast (0.028 ± 0.019 birds per ha) when the habitat classified as *good* was considered in each study (Burger 2002). The underlying cause of this regional difference is not known.

Risk modelling of B.C. populations indicated that the certainty of population outcome was affected by management choices of how much and what type of old forest to maintain (Steventon et al., in press). The modelling also indicated that rate of decline of nesting habitat had little influence on long-term population outcome, but the eventual nesting capacity (area and quality of habitat) when it did stabilize was important.

Legal Protection and Habitat Conservation

Marbled Murrelets and their nests and eggs are protected from direct persecution under the Canadian *Migratory Birds Convention Act, 1994*, and the provincial *Wildlife Act* (Section 34). As a federally listed species the Marbled Murrelet will come under the jurisdiction of the *Species at Risk Act* (SARA).

Several protected areas are important for the conservation of the Marbled Murrelet including Carmanah-Walbran Provincial Park, Pacific Rim National Park, Strathcona Provincial Park and other coastal protected areas in Clayoquot Sound, Gwaii Haanas National Park Reserve, and several of the larger protected areas on the central mainland coast. Smaller areas of habitat in the water-supply catchments for the cities of Vancouver and Victoria are also important, because surrounding habitat areas have been greatly depleted.

Marbled Murrelets were listed as *Threatened* by the Committee on Status of Endangered Wildlife in Canada (COSEWIC) in 1990. The Marbled Murrelet Recovery Team published the first Recovery Plan (Kaiser et al. 1994), which focused on data gaps and research priorities. Following a second review (Hull 1999), the Threatened status was confirmed in 2000, primarily on the basis of low reproductive rate and continued evidence of declining nesting habitat (D. Fraser, pers. comm.). A revised recovery strategy and action plan are being drafted by the recovery team, based upon the 2001–2002 Conservation Assessment (Hooper 2001; Burger 2002; Steventon et al., in press). The main conservation and management points have already been identified (MMRT 2003).

Identified Wildlife Provisions

Sustainable resource management and planning recommendations

Over the last two years, the provincial ministries and the national Marbled Murrelet Recovery Team (MMRT) have collaborated on a conservation assessment of the Marble Murrelet. Part A[2] of the assessment has recently been published, Part B[3] has been released by the MMRT, and Part C[4] is in press. These documents incorporate the latest science on this species and represent the consensus of the multi-stakeholder MMRT, which has members from government, industry, academia, and ENGOs. The conservation assessment documents will be used by the MMRT in preparing a Recovery Strategy for the species as required under the federal *Species At Risk Act*. The completed Recovery Strategy is expected by March 2004.

---

[2] Burger, A.E. 2002. Conservation assessment of Marbled Murrelets in British Columbia: a review of the biology, populations, habitat associations and conservation. CWS, Pacific and Yukon Region, British Columbia. Tech. Rep. Ser. No. 387.

[3] Canadian Marbled Murrelet Recovery Team. 2003. Marbled Murrelet Conservation Assessment 2003, Part B: Marbled Murrelet Recovery Team Advisory Document on Conservation and Management. Canadian Marbled Murrelet Recovery Team Working Document No. 1.

[4] Steventon, D. *et al.* In press. Analysis of Long-term Risks to Regional Marbled Murrelet *(Brachyramphus marmoratus)* Populations Under Alternative Forest Management Policies on Coastal British Columbia.

The conclusions and recommendations contained in Parts B and C of the Conservation Assessment have not been adopted as government policy. Therefore, until there is a new government decision on the management of Marbled Murrelet, government agencies (MSRM, MOF and MWLAP) will continue to work with industry to develop Marbled Murrelet WHAs through policies established since 1999 regarding WHA impacts; that is, overlapping WHAs with old growth management areas (OGMAs) through landscape unit planning and with other constrained areas such as ungulate winter ranges and visual resource management areas, use of a portion of the IWMS one percent timber supply impact cap on the timber harvesting land base (THLB), and establishment of other WHAs on the non-contributing land base (NCLB). Part B of the Conservation Assessment can be consulted for information on the suitable size and characteristics (shape, habitat suitability) of individual WHAs, but the amount of habitat to be established as WHAs remains constrained by existing policy. This direction applies to all areas where WHA establishment is taking place unless new objectives are approved by government.

Forest licensees are encouraged to continue working with agency staff to propose WHAs in accordance with the current policy direction. It is also recognized that, under the *Forest and Range Practices Act*, licensees will have the option of proposing alternative strategies for managing Marbled Murrelet habitat.

Three of the Marbled Murrelet conservation regions identified by the Conservation Assessment – the Central Mainland Coast, the Northern Mainland Coast and the Queen Charlotte Islands) – fall under strategic land use planning exercises (SLUPs). While the current policy direction on Marbled Murrelet habitat applies to all areas in the species' range, it is not intended to impede, delay, or constrain negotiations or forthcoming recommendations of the three coastal SLUPS.

Table 2. Estimates of current (2002) populations of Marbled Murrelets in each conservation region, and Marbled Murrelet Recovery Team recommendations for maximum declines in population and habitat per region by 2032, assuming a decline of no more than 30% in population size and habitat area for all of British Columbia, and having less reduction in regions already thought to have depleted populations (MMRT 2003)

Conservation region	Estimated population in 2002 (birds)[a]	Maximum allowable decline of population and habitat[b] by 2032 (%)
West & North Vancouver Island	19 400–24 500	31
East Vancouver Island[c]	700–1 000	0–10
Southern Mainland Coast	6 000–7 000	15
Central Mainland Coast	10 000–21 000	31
Northern Mainland Coast	10 100–14 600	31
Haida Gwaii (QCI)	8 500–9 500	31
Total for British Columbia	**54 700–77 600**	**30**

[a] Range indicates the pessimistic and optimistic population estimates. Population estimates are made using birds and not breeding pairs or nests because the at-sea and radar counts used to derive population estimates do not distinguish between breeding and non-breeding birds. Birds are therefore the unit of population measure throughout this account.

[b] Note that a small proportion of nesting birds may breed outside areas of habitat that are able to be identified through air photo interpretation or helicopter surveys (L. Waterhouse, pers. comm.).

[c] The Marbled Murrelet Recovery Team (2003) recommended that, if possible, no further habitat reduction should occur in this region, and if that was not possible then the population should decline by no more than 10% in 2002–2032.

Wildlife habitat area

Because of the unique nature of Marbled Murrelet management direction in British Columbia (i.e., historical reliance primarily on OGMAs for establishing WHAs to protect nesting habitat), the following paragraph is provided as context for Marbled Murrelet WHA development.

To the degree possible within government policy direction limiting impacts on timber supply, areas of suitable Marbled Murrelet habitat (Table 3) should be maintained and protected, in combination with other constrained areas, to achieve the habitat objectives of Table 2 and the spatial distribution recommended for each conservation region by the Marbled Murrelet Recovery Team (MMRT 2003). When calculating total areas of maintained habitat in each conservation region or landscape unit, apply the same habitat selection criteria to protected and to non-protected areas.

Goal

Maintain suitable Marbled Murrelet nesting habitat (Table 3).

Features

Establish WHAs in suitable Marbled Murrelet nesting habitat, as defined in Table 3 and the text below. *Each habitat feature should not be used in isolation but in combination with others to ensure selection of suitable habitat.* Ideally WHAs should be established in habitats identified as "Most Likely" to contain suitable features. Habitat rated as "Moderately Likely" may be considered for WHAs but will require confirmation as suitable habitat using approved methods of ground or helicopter surveys. Areas rated as "Least Likely" should only be considered if there is evidence of nesting (nests, eggshells, or occupied detections), or strong evidence that the particular site provides the necessary microhabitat attributes (Table 1), such as platform limbs (>15 cm diameter including epiphytes) and variable canopy structure, and is within commuting distance of likely foraging areas at sea.

The CWH and CDF biogeoclimatic zones are preferred over MH (Burger 2002). Fine-scale biogeoclimatic attributes are best applied through selection of site index productivity classes (Green and Klinka 1994). Stands classified as age class 8 (140–250 yr) might provide suitable habitat but this needs to be confirmed through ground truthing; stands of age class 7 or less (<140 yr) are unlikely to provide suitable habitat, unless there are suitable old seral veteran trees or other trees with suitable platforms present. Most nests have been found in height class 5 or larger (>37 m tall), but smaller trees can provide suitable habitat especially in higher elevations and latitudes. Height classes on forest cover maps generally reflect average conditions in a polygon and might not be accurate for all parts of a polygon. Some multi-layered polygons with low height class ratings (e.g., class 2 with a veteran layer) might provide suitable trees, but these need to be confirmed by field assessments before accepting such polygons as suitable habitat.

Canopy vertical complexity is an important habitat attribute and is generally a better predictor of suitable habitat than crown closure. Aerial photographs can be used to assess and rank vertical complexity. Slope should be regarded as a neutral feature at the landscape scale, but topographic variability provided by slopes, small rock outcrops, avalanche chutes, gullies, riparian zones, and small ridges are hypothesized to improve forest value as nest habitat by breaking up the continuity of the forest canopy and improving access to the canopy for murrelets.

Aspect, moisture regimes, and exposure to wind and sea-spray need to be considered if there is evidence that these affect the availability of nesting platforms by inhibiting moss development on tree limbs.

Size

Within managed forests, maintain a balanced range of patch sizes. Patch size composition will vary depending on the existing habitat options. Until the effects of patch size are better understood, the Recovery Team recommends maintaining a mix of large (>200 ha), medium (50–200 ha), and small (<50 ha) patches within managed forests.

Table 3. Features of Marbled Murrelet nesting habitat to consider during selection and design of WHAs and other maintained habitat patches. The features are grouped by the likelihood that polygons with these features will contain a large proportion of suitable nesting habitat. Additional features are described in the text. Features should not be used in isolation but in combination with other features.

Feature	Most likely	Moderately likely	Least likely
Distance from saltwater (km): all regions	0.5–30	0–0.5 & 30–50	>50
Elevation (m):			
Central & Northern Mainland Coast	0–600	600–900	>900
Haida Gwaii (QCI)	0–500	500–800	>800
All other regions	0–900	900–1500	>1500
Stand age class: all regions	9 (>250 yr)	8 (140–250 yr)	<8 (<140 yr)
Site index productivity classes: all regions[a]	Class I & II (site index 20+)	Class III (site index 15–19)	Class IV (site index <15)
Tree height class: all regions[b]	4–7 (>28.5 m)	3 (19.5–28.4 m)	<3 (<19.5 m)
Canopy closure class: all regions	Classes 4, 5, & 6	Classes 3 & 7	Classes 2 & 8
Vertical canopy complexity: all regions[c]	MU, NU, & VNU	U	VU

[a] Productivity classes as defined in Green and Klinka (1994, p. 197); approximate 50-year site index values also given – application of these indices might vary with different tree species and across regions.

[b] Nests have been found in polygons ranked height class 1 or 2 but the nests were in larger trees than the polygon average.

[c] Vertical complexity ranked from least to highest (see Waterhouse et al. 2002). VU = very uniform (<11% height difference leading trees and average canopy, no evidence of canopy gaps or recent disturbance). U = uniform (11–20% height difference, few canopy gaps visible, little or no evidence of disturbance. MU = moderately uniform (21–30% height difference, some canopy gaps visible, evidence of past disturbance, stocking may be patchy or irregular. NU = non-uniform (31–40% height difference, canopy gaps often visible due to past disturbance, stocking typically patchy or irregular). VNU = very non-uniform (>40% difference, very irregular canopy, stocking very patchy or irregular).

Design

Where possible, follow the steps in Table 4 for selecting nesting habitat for WHAs.

As much as possible, minimize edge effects in WHAs by avoiding elongated or amoeboid shapes with large "hard" edges (defined above), and by establishing WHA boundaries along natural forest edges or with buffers of older second growth. Maintain windfirm boundaries to WHAs (Stathers et al. 1994) but minimize edge-feathering and topping that might remove potential nesting habitat. WHAs bordered entirely by natural edges (e.g., between avalanche chutes or rivers) need not be restricted by shape or size.

Wherever possible buffer the effects of roads, clearcuts, human communities, logging camps, and recreation sites, by leaving borders of maturing forest (>40 yr) around the old seral nesting habitat.

If there has to be a trade-off between maintaining suitable nesting habitat for WHAs or maintaining maturing buffer zones around WHAs, select the nesting habitat. An exception might be made if there is strong evidence that the buffer zone will mature into old forest with more favourable attributes as nesting habitat than other existing old forest available for WHAs in the same landscape unit cluster.

Forests within 0.5 km of shores that are exposed to open ocean or have high densities of shoreline predators (e.g., corvids) are generally considered less suitable habitat (Burger 2002), but they should be included within a WHA to buffer against wind and sea spray.

General wildlife measures

Goals

1. Maintain important habitat features such as adequate large trees providing suitable nest platforms and vertical canopy complexity.
2. Minimize activities and habitat modifications that might attract predators (e.g., recreational sites may attract nest predators, such as crows, ravens, jays, or squirrels).
3. Minimize "hard edges" (defined in "Habitat threats" section) that might attract edge predators, allow windthrow, or adversely affect canopy microclimates.
4. Minimize disturbance to nesting birds during the breeding season (late-April through early September).

Measures

Access

- Do not construct or widen roads unless there is no other practicable option.

Harvesting and silviculture

- Do not harvest except for salvage.

Pesticides

- Do not use pesticides.

Recreation

- Do not develop recreational structures, trails, or facilities.

Table 4. Recommended steps in selecting WHAs and other maintained nesting habitat for Marbled Murrelets

Goals for each step	Tools and procedures
1. Identify habitat polygons to be considered for WHAs and other maintained nesting habitat	Apply regionally specific habitat algorithms and recognized habitat indicators (see Tables 1 and 3, and associated text) to forest cover maps, or similar recognized GIS databases. See also strategic planning section above.
2. Assess and rank the polygons based on evidence of suitable canopy structure and stand features.	Air photo interpretation (Donaldson, in press), focusing on vertical complexity, tree height, stand age, and other regionally relevant parameters in Tables 1 and 3.
3. Confirm that the ranked polygons are suitable habitat	One or more of the following:(a) evidence of nesting (nests, eggshells); (b) evidence of stand occupancy using audio-visual surveys (RIC 2001); (c) evidence of suitable microhabitat features (Table 1) using ground transects or plots (RIC 2001); (d) evidence of suitable microhabitat features (Table 1) from low-level helicopter surveys (Burger et al., in press).
4. Select among the polygons classified as suitable habitat sufficient to meet the area requirements for the specific landscape unit, landscape unit cluster, or other management unit under consideration.	Maintained habitat can be a combination of polygons classified as Most Likely or Moderately Likely that is confirmed to have nesting, occupancy or suitable habitat. Polygons ranked Least Likely should only be included if there is recent evidence of murrelet nests or occupancy by murrelets likely to be breeding, or strong evidence of suitable canopy attributes within commuting distance of marine feeding sites.

Additional Management Considerations

Partial retention harvesting should not be undertaken in WHAs until its effects on murrelets are known.

Information Needs

1. Criteria and methods for identifying and mapping suitable nesting habitat need to be refined. Standard protocols for using aerial photographs and low-level helicopter reconnaissance to identify suitable habitat need to be confirmed.
2. The distribution and area of suitable habitat across coastal British Columbia need to be accurately mapped.
3. Better information is needed on the size, distribution, and habitat use of regional populations to refine habitat requirements in each conservation region.
4. The effects of forest edges and patch size on nest-site selection and breeding success need to be measured in a wide range of habitats.
5. The effects of partial retention harvesting and roads on nesting Marbled Murrelets need to be investigated.

Refer to the Marbled Murrelet Recovery Team for updates on research priorities.

Cross References

Great Blue Heron, Grizzly Bear, Keen's Long-eared Myotis, "Queen Charlotte" Goshawk, "Queen Charlotte" Northern Saw-whet Owl

References Cited

American Ornithologists' Union (AOU). 1997. Forty-first supplement to the American Ornithologists' Union check-list of North American birds. Auk 114:542–552.

Beauchamp, W.D., F. Cooke, C. Lougheed, L.W. Lougheed, C.J. Ralph, and S. Courtney. 1999. Seasonal movements of Marbled Murrelets: evidence from banded birds. Condor 101:671–674.

Beissinger, S.R. and N. Nur. 1997. Appendix B: Population trends of the Marbled Murrelet projected from demographic analysis. *In* Recovery plan for the threatened Marbled Murrelet (*Brachyramphus marmoratus*) in Washington, Oregon and California. U.S. Fish Wildl. Serv., Portland, Oreg., pp. B1–B35.

Bradley, R.W. 2002. Breeding ecology of radio-marked Marbled Murrelets in Desolation Sound, British Columbia. M.Sc. thesis. Simon Fraser Univ., Burnaby, B.C.

Bradley, R.W. and F. Cooke. 2001. Cliff and deciduous tree nests of Marbled Murrelets in southwestern British Columbia. Northwest. Nat. 82:52–57.

Burger, A.E. 2001. Using radar to estimate populations and assess habitat associations of Marbled Murrelets. J. Wildl. Manage. 65:696–715.

_____. 2002. Conservation assessment of Marbled Murrelets in British Columbia: review of the biology, populations, habitat associations, and conservation. Can. Wildl. Serv., Delta, B.C. Tech. Rep. Ser. No. 387.

Burger, A.E., B.R. Smart, L.K. Blight, and J. Hobbs. In press. Standard methods for identifying and ranking nesting habitat of Marbled Murrelets in British Columbia. PART B: low-level aerial reconnaissance methods. B.C. Min. Water, Land and Air Prot., Victoria, BC. Unpubl.

Cam, E., L.W. Lougheed, R.W. Bradley, and F. Cooke. In press. Demographic assessment of a Marbled Murrelet population from capture-mark-recapture data. Conserv. Biol.

Canadian Marbled Murrelet Recovery Team. 2003. Marbled Murrelet Conservation Assessment 2003, Part B: Marbled Murrelet Recovery Team Advisory Document on Conservation and Management. Canadian Marbled Murrelet Recovery Team Working Document No. 1.

Committee on the Status of Endangered Wildlife in Canada (COSEWIC). 2002. Canadian species at risk. Available from: http://www.speciesatrisk.gc.ca

Demarchi, D.A. and A.A. Button. 2001a. Marbled Murrelet nesting habitat capability in British Columbia: Map 2 – weighted average capability. B.C. Min. Environ., Lands and Parks, Resour. Inv. Br., Victoria, B.C. Map @ 1:300,000.

_____. 2001b. Marbled Murrelet nesting habitat suitability in British Columbia: Map 3 – weighted average suitability. B.C. Min. Environ., Lands and Parks, Resour. Inv. Br., Victoria, B.C. Map @ 1:300,000.

Donaldson, A. In press. Standard methods for identifying and ranking nesting habitat of Marbled Murrelets in BC. Part A: air photo interpretation. Report to B.C. Min. Water, Land and Air Prot., Victoria, B.C. Unpubl.

Gaston, A.J. and I.L. Jones. 1998. The auks Alcidae. Oxford Univ. Press, Oxford, U.K.

Green, R.N. and K. Klinka. 1994. A field guide to site identification and interpretation for the Vancouver Forest Region. B.C. Min. For., Res. Br., Victoria, B.C. Land Manage. Handb. No. 28.

Hamer, T.E. and S.K. Nelson. 1995. Characteristics of Marbled Murrelet nest trees and nesting stands. *In* Ecology and conservation of the Marbled Murrelet. C.J. Ralph, G.L. Hunt, Jr., M.G. Raphael, and J.F. Piatt (editors). U.S. Dep. Agric. For. Serv., Pac. SW Res. Stn., Albany, Calif., Gen. Tech. Rep. PSW-GTR-152, pp. 69–82.

Hooper, T.D. 2001. Research and inventory of Marbled Murrelets (*Brachyramphus marmoratus*) in British Columbia: 1991-1999. Report to Can. Wildl. Serv., Pac. and Yukon Reg., Delta, B.C. Unpubl.

Hull, C.L. 1999. COSEWIC status report update on Marbled Murrelet *Brachyramphus marmoratus* (Gmelin). Report to Committee on the Status of Endangered Wildlife in Canada (COSEWIC). Simon Fraser Univ., Cent. Wildl. Ecol., Burnaby, B.C.

Hull, C.L., G.W. Kaiser, C. Lougheed, L. Lougheed, S. Boyd, and F. Cooke. 2001. Intra-specific variation in commuting distance of Marbled Murrelets (*Brachyramphus marmoratus*): ecological and energetic consequences of nesting further inland. Auk 118:1036–1046.

Kaiser, G.W., H.J. Barclay, A.E. Burger, D. Kangasniemi, D.J. Lindsay, W.T. Munro, W.R. Pollard, R. Redhead, J. Rice, and D. Seip. 1994. National Recovery Plan for the Marbled Murrelet. Recovery of Nationally Endangered Wildlife Committee, Can. Wildl. Serv., Ottawa, Ont. Rep. No. 8.

Lougheed, C., L.W. Lougheed, F. Cooke, and S. Boyd. 2002a. Local survival of adult and juvenile Marbled Murrelets and their importance for estimating reproductive success. Condor 104:309–318.

Lougheed, C., B.A. Vanderkist, L.W. Lougheed, and F. Cooke. 2002b. Techniques for investigating breeding chronology in Marbled Murrelets, Desolation Sound, British Columbia. Condor 104:319–330.

McFarlane Tranquilla, L.A. 2001. Using multiple methods to describe breeding, stress response, and disturbance of Marbled Murrelets (*Brachyramphus marmoratus*). M.Sc. thesis. Simon Fraser Univ., Burnaby, B.C.

Manley, I.A. 1999. Behaviour and habitat selection of Marbled Murrelets nesting on the Sunshine Coast. M.Sc. thesis. Simon Fraser Univ., Burnaby, B.C.

Manley, I.A. and S.K. Nelson. 1999. Habitat characteristics associated with nest success and predation at Marbled Murrelet tree nests (Abstract). Pac. Seabirds 26:40.

Marbled Murrelet Recovery Team (MMRT). 2003. Marbled Murrelet Conservation Assessment 2003, Part B – Marbled Murrelet Recovery Team advisory document on conservation and management. Available from the Can. Wildl. Serv., Delta, B.C.

Masselink, M.N.M. 2001. Responses by Steller's Jay to forest fragmentation on southwest Vancouver Island and potential impacts on Marbled Murrelets. M.Sc. thesis. Univ. Victoria, Victoria, B.C.

NatureServe Explorer. 2002. An online encyclopedia of life [Web application]. Version 1.6. Arlington, Va. Available from: http://www.natureserve.org/explorer

Nelson, S.K. 1997. Marbled Murrelet *Brachyramphus marmoratus. In* The birds of North America, No. 276. A. Poole and F. Gill (editors). Acad. Nat. Sci., Philadelphia, Penn., and Am. Ornithol. Union, Washington, D.C.

Ralph, C.J., G.L. Hunt Jr., M.G. Raphael, and J.F. Piatt (editors). 1995. Ecology and conservation of the Marbled Murrelet in North America. U.S. Dep. Agric. For. Serv., Pac. SW Res. Stn., Albany, Calif., Gen. Tech. Rep. PSW-GTR-152.

Raphael, M.G., D. Evans Mack, J.M. Marzluff, and J.M. Luginbuhl. 2002. Effects of forest fragmentation on populations of the Marbled Murrelet. Stud. Avian Biol. 25:221–235.

_____. 2001. Inventory methods for Marbled Murrelets in marine and terrestrial habitats, Version 2.0. Standards for components of British Columbia's biodiversity, No. 10. B.C. Min. Environ., Lands and Parks, Victoria, B.C. Available from: http://srmwww.gov.bc.ca/risc/pubs/tebiodiv/index.htm

Stathers, R.J., T.P. Rollerson, and S.J. Mitchell. 1994. Windthrow handbook for British Columbia forests. B.C. Min. For., Res. Br., Victoria, B.C. Work. Pap. 9401.

Steventon, J.D., G.L. Sutherland, and P.E. Arcese. In press. Analysis of long-term risks to regional marbled murrelet (*Brachyramphus marmoratus*) populations under alternative forest management policies in coastal British Columbia. B.C. Min. For., Res. Program and For. Practices Br., Victoria, B.C.

Waterhouse, F.L., R. Bradley, J. Markila, F. Cooke, and L. Lougheed. 2002. Use of airphotos to identify, describe and manage forest structure of Marbled Murrelet nesting habitat at a coastal British Columbia site. B.C. Min. For., Vancouver For. Reg., Res. Sect., Nanaimo, B.C. Tech. Rep. TR-016.

Whitworth, D.L., S.K. Nelson, S.H. Newman, G.B. van Vliet, and W.P. Smith. 2000. Foraging distances of radio-marked Marbled Murrelets from inland areas in southeast Alaska. Condor 102:452–456.

Personal Communications

Fraser, D. 2003. Min. Water, Land and Air Protection, Victoria, B.C.

"QUEEN CHARLOTTE" GOSHAWK

Accipiter gentilis laingi

Original prepared by Erica McClaren

Species Information

Taxonomy

Two subspecies of goshawks are recognized in British Columbia: *Accipiter gentilis atricapillus* and *A. gentilis laingi* (AOU 1957; Palmer 1988). The subspecies *A. gentilis laingi*, referred to as the Queen Charlotte Goshawk, was described from a type-specimen from the Queen Charlotte Islands by Taverner (1940). Taverner (1940) described the subspecies as being faintly to distinctly darker than *A. gentilis atricapillus*. Adults were described as sootier grey ventrally with the black cap and nape extending over the shoulders and interscapulars, dorsally (Taverner 1940). He described juveniles as having breast streaks that were very broad and deeper in colour than *A. gentilis atricapillus* and as darker brown, dorsally (Taverner 1940). This subspecies was thought to inhabit islands of coastal British Columbia, primarily the Queen Charlotte Islands and Vancouver Island (Taverner 1940). Later, *A. gentilis laingi* was also described as having shorter wing lengths (based on wing curvature) (Johnson 1989; Whaley and White 1994) and smaller toes than *A. gentilis atricapillus* (Whaley and White 1994). Whaley and White (1994) speculated that the ecological significance of *A. gentilis laingi*'s smaller size was for increased manoeuvrability through the dense coastal forests and an increased component of avian prey relative to mammalian prey in its diet.

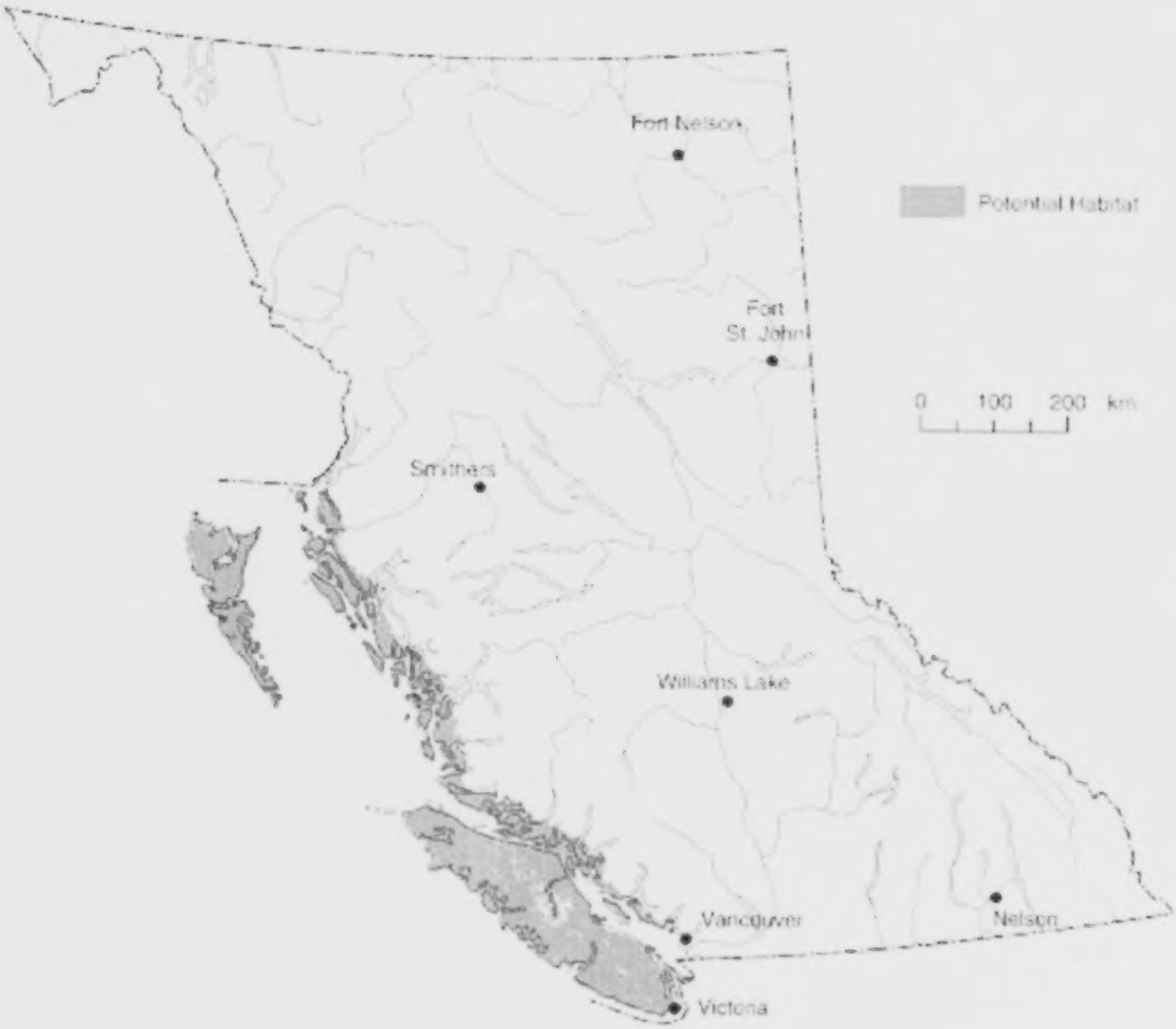
Gavin and May (1995) conducted a genetic analysis of goshawks throughout North America using allozymes, random amplified polymorphic DNA (RAPDs), restriction fragment length polymorphism (RFLPs) of monomorphic RAPD generated bands, and microsatellites in their analyses. They concluded that goshawks exhibited very little genetic variation throughout their range but acknowledged that they did not include genetic samples from the Queen Charlotte Islands or Vancouver Island thus were unable to address whether *A. gentilis laingi* was a genetically distinct subspecies. Currently, the debate over the subspecific designation of *A. gentilis laingi* continues while further genetic analyses are being conducted by Sandra Talbot in Alaska. These analyses include blood samples from Vancouver Island, southeast Alaska, and the central coast of British Columbia, but only one sample from the Queen Charlotte Islands. Preliminary analyses suggest that goshawk populations in southeast coastal Alaska and Vancouver Island are genetically differentiated from populations in interior Alaska and British Columbia (S. Talbot pers. comm.).

Description

Queen Charlotte Goshawks are raven-sized (53–66 cm length; NGS 1999) forest-dwelling raptors with short rounded wings and long tails. Adults (>2 years) have a conspicuous light grey supercilium flaring out behind the eye that separates their black crown from their blue-grey back. Underparts are white with dense grey barring that appears light grey from a distance. In general, females are darker brown above as adults than males and have coarser grey barring on their undersides. The tail has bands of alternating light and dark. Adults have white and grey flecked undertail coverts that flare out when individuals are agitated or when they are conducting aerial displays. Adult eye colour varies from yellow to dark red and generally becomes darker with age. Immature goshawks (<2 years) have a faint light grey supercilium and are brown above and buffy below with thick, dark brown streaks. The tail has alternating brown and black bands, with white edges. Immature undertail coverts are white with brown tear-shaped streaks. Tarsi and toes are greenish grey to pale yellow as immatures, becoming yellow as adults, while talons appear bluish-black to

Northern Goshawk - subspecies *laingi*

(Accipiter gentilis laingi)


Fort Nelson
Potential Habitat
Fort St. John
0 100 200 km
Smithers
Williams Lake
Vancouver
Nelson
Victoria

Note: This map represents a broad view of the distribution of potential habitat used by this species. The map is based on several ecosystem classifications (Ecoregion, Biogeoclimatic and Broad Ecosystem Inventory) as well as current knowledge of the species' habitat preferences. This species may or may not occur in all areas indicated.

black (Squires and Reynolds 1997). Feathers continue approximately midway down the front of the tarsus (Squires and Reynolds 1997). Intermediate plumages between immature, subadult, and adult ages are described by Bond and Stabler (1941) and Squires and Reynolds (1997). These descriptions are based on those outlined by Squires and Reynolds (1997), NGS (1999), and Sibley (2000).

References to goshawks throughout the remainder of this account apply to *A. gentilis laingi* unless reported as Northern Goshawk (*A. gentilis atricapillus* or *A. gentilis gentilis*).

Distribution

Global

Queen Charlotte Goshawks occur along the Pacific Coast from Vancouver Island north to the Alexander Archipelago in southeast Alaska, coastal mainland Alaska and Lynn Canal (Webster 1988; Titus et al. 1994; Iverson et al. 1996; Ethier 1999).

British Columbia

British Columbia contains the majority of the Queen Charlotte Goshawk population worldwide. The Queen Charlotte Goshawk occurs on Vancouver Island, the Queen Charlotte Islands, and smaller coastal islands between Vancouver Island and mainland British Columbia. Their distribution throughout coastal mainland British Columbia is unknown, but radio-tagged individuals from Vancouver Island have moved to breed on adjacent coastal islands (McClaren 1997, 1999). As well, two goshawks from Vancouver Island have moved to adjacent coastal mainland during the winter (McClaren 2000, 2001). Most likely, Queen Charlotte Goshawks also inhabit forests on the west side of the Coast Mountains throughout coastal mainland British Columbia.

Forest region and districts

Coast: Campbell River, North Coast, North Island, Queen Charlotte Islands, South Island, Sunshine Coast

Ecoprovinces and ecosections

COM: NIM, NWL, QCL, SKP, WIM, WQC, (CBR, HEL, OUF, SBR – possible)

GED: LIM, NAL, SGI, SOG, (GEL – possible)

Biogeoclimatic units

CDF: mm

CWH: dm, mm, vh, vm, wh, xm

MH: mm, wh

Broad ecosystem units

CB, CD, CH, CR, CW, DA, FR, HL, HS, SR, YB

Elevation

Documented to breed between sea level and 900 m (Iverson et al. 1996; McClaren 2003) but may use higher elevations for foraging throughout the year (McClaren 1997, 1998, 1999; D. Doyle, pers. obs.).

Life History

Diet and foraging behaviour

Goshawks are considered opportunistic hunters, foraging on a variety of medium-sized birds and mammals throughout the year (Squires and Reynolds 1997). The majority of data on diet has been collected from goshawks during the breeding season (Vancouver Island: Ethier 1999; E.L. McClaren, unpubl. data; southeast Alaska: Iverson et al. 1996; Lewis 2001; Olympic Peninsula: Bloxton, in prep.). Most prey items include forest dwelling birds and mammals. Red Squirrels (*Tamiasciurus hudsonicus*), thrushes, jays, woodpeckers, Marbled Murrelet (*Brachyramphus marmoratus*), and grouse were the main prey in pellets found below active nest sites on Vancouver Island (Ethier 1999; E.L. McClaren, unpubl. data). Goshawk pellets from southeast Alaska contained similar prey species as those from Vancouver Island, but they had a higher component of members from the Alcidae family and Northwestern Crows (*Corvus caurinus*) (Iverson et al. 1996). Only anecdotal evidence is available to describe the prey items goshawks use during the winter. However, because fewer prey species are available to goshawks during the winter, certain species may be critical to goshawks during this time.

The rounded wings and long tail of goshawks make them well suited for manoeuvring through forested habitats while hunting. However, few data have been collected from radio-tagged birds while they are foraging or at kill sites. Therefore, our knowledge of Queen Charlotte Goshawk foraging habitat characteristics is limited (Squires and Reynolds 1997).

Reproduction

Queen Charlotte Goshawks typically do not breed until they are >2 years although, occasionally, they will breed in their second year (McClaren 2003). Individuals return to their breeding sites between early February and late March (ADFG 1996; E.L. McClaren, unpubl. data). Courtship consists of aerial displays, dawn vocalizations, nest building/ repair, and frequent copulation, and occurs between February and early April, with peak activity occurring in March (Beebe 1974; Chytyk et al. 1997; A. Zeeman, unpubl. data). One to four eggs are laid mid- to late April and incubation (by the female primarily) occurs for 30–32 days (Beebe 1974; Iverson et al. 1996; E.L. McClaren, unpubl. data). During late courtship and early incubation, the female is primarily fed by the male (Cooper and Stevens 2000). Hatching occurs between late May and mid-June with typically one to three young fledging after 38–42 days in early to mid-July (ADFG 1996; McClaren and Pendergast 2002). Females assist males with hunting during the second half of the nestling phase; however, the timing varies and is influenced by brood size, food supply, and the male's hunting performance (Squires and Reynolds 1997; Dewey and Kennedy 2001). Fledglings remain near the nest (the post-fledging area [PFA]) for 40–60 days, after which they disperse and become independent of adults (Kenward et al. 1993; Kennedy et al. 1994; McClaren and Pendergast 2002). Dispersal occurs between early August to early September (Iverson et al. 1996; McClaren and Pendergast 2002).

Site fidelity

Nest site fidelity is the occupancy of the same nest area, by the same individual or pair of goshawks, in subsequent breeding seasons (Reynolds and Joy 1998). Nest site fidelity in goshawks is difficult to estimate because breeding goshawks can be secretive, making detection of alternative nest site locations and banded individuals laborious. Overall, site fidelity for the Queen Charlotte Goshawk appears to be greater for males than females, which concurs with studies on Northern Goshawks (California: Detrich and Woodbridge 1994; Arizona: Reynolds and Joy 1998). Studies in southeast Alaska have shown that radio-tagged males exhibit high site fidelity, whereas some females moved to new nest areas and mated with different males (Iverson et. al. 1996). All areas that females dispersed to included a portion of their winter home range (Iverson et al. 1996). On Vancouver Island, turnover rate of marked females was 78.9% (n = 57) with a maximum turnover rate of six consecutive years of occupancy by six different females within one nest area (McClaren 2003). It was not possible to calculate turnover rates for males because trapping success for males was less successful. Similar to southeast Alaska, breeding dispersal movements by radio-tagged males on Vancouver Island have not been observed (E.L. McClaren, unpubl. data). Between 1995–2002, goshawks on Vancouver Island used nest trees 1.6 years ($n = 72$), on average, similar to other studies in North America (Squires and Reynolds 1992; McClaren 2003).

Home range

The size of goshawk breeding home ranges varies according to the familiarity of individuals with their home range, differences in hunting efficiency, food requirements (brood size), and food availability (Kennedy et al. 1994). For example, in California, breeding home ranges averaged 1280 ha ($n = 5$) for Northern Goshawk females and 1880 ha ($n = 5$) for males (Keane and Morrison 1994) whereas in southeast Alaska, breeding home ranges for Queen Charlotte Goshawks averaged 19 215 ha ($n = 8$) for females and 5847 ha ($n = 8$) for males (Titus et al. 1994). In southeast Alaska, female breeding season home ranges were primarily <1000 ha; however, two females made large movements away from their breeding areas during the post-fledging period, dramatically increasing estimates of mean breeding season home range size (Titus et al. 1994). In southeast Alaska, goshawks travel among small islands to forage, thereby increasing travel distances to find food. Breeding home range size estimates for Queen

Charlotte Goshawks in other parts of their range are not available. However, nesting density, the distance between adjacent active nests, may approximate breeding home range size. In the Nimpkish Valley and Gold River on Vancouver Island, mean nesting density for goshawks is 6.9 ± 0.7 ($n = 16$) (McClaren 2003).

Goshawk breeding home ranges appear to be composed of a nest area, PFA, and foraging area (Reynolds et al. 1992). The nest area often contains several alternative nest trees, roost trees, plucking posts, and is the centre of courtship behaviour and fledgling movements during the early post-fledging period (Reynolds et al. 1982; Kennedy et al. 1994; McClaren and Pendergast 2002). Goshawk nest areas may or may not be contained within the same forest stand (Reynolds et al. 1992; Squires and Reynolds 1992). Nest areas vary in size and shape depending on topography and the availability of suitable habitat (Reynolds 1983; Ethier 1999). On Vancouver Island, 95% of alternative nest trees within a nest area occur within 800 m of each other, suggesting that nest areas on Vancouver Island are approximately 200 ha (McClaren 2001). Although several nest trees occur <800 m from one another, the likelihood of locating nests farther is less. Therefore, 200 ha is a conservative estimate of the actual nest area. Because alternative nest spacing appears to be greater for the Queen Charlotte Goshawk than for the Northern Goshawk (Iverson et al. 1996; McClaren 2001; McClaren and Pendergast 2002), nest area size is more comparable to post-fledging size in this subspecies.

The PFA is the area used by fledglings before they become independent of adults and disperse (Kennedy et al. 1994). The PFA surrounds and includes the active nest area and corresponds roughly with the female core-use area (Kennedy et al. 1994). Post-fledging areas vary in size. Kennedy et al. (1994) reported a mean size of 170 ha for *A. gentilis atricapillus,* whereas estimates from the Kispiox and Lakes areas of British Columbia suggest PFA size is much smaller, averaging <20 ha (Doyle and Mahon 2000; Mahon and Doyle 2001). Both these PFA estimates for Northern Goshawks are smaller than the estimated nest area and PFA size for Queen Charlotte Goshawks. Preliminary data suggest that PFAs on Vancouver Island are similar in size to those originally proposed by Reynolds et al. (1992) and Kennedy et al. (1994) (McClaren and Pendergast 2002). Research on radio-tagged fledglings on Vancouver Island in 2001 and 2002 suggests PFA size for Queen Charlotte Goshawks is approximately equivalent to nest area size (McClaren and Pendergast 2002). Post-fledging area size estimates from 12 fledglings on Vancouver Island was 58.6 ± 11 ha. Allowing for multiple PFAs around alternative nests and some buffering from edge suggests a nest area PFA size of 200 ha. Larger PFA estimates for Queen Charlotte Goshawks than for Northern Goshawks may result from lower prey densities and larger home ranges in coastal forests than interior forests.

Foraging areas make up most of an individual's breeding home range and they are comprised of the areas where adult male and female goshawks hunt. Foraging areas may include the nest area and PFA. It is believed adult males do not hunt directly within the nest area and PFA to maintain locally abundant food supplies for adult females and for fledglings when they are learning to hunt (Kennedy et al. 1994). Foraging areas vary in size among locales and among individual goshawks according to the experience of individuals within their breeding home range, differences in their hunting efficiency, food requirements (brood size), and the availability of food within their home ranges (Kennedy et al. 1994). Few studies have estimated the foraging area size for Queen Charlotte Goshawks because limited information is available on goshawk foraging activities. Most often, the size of the foraging area is based on breeding home size for goshawks with the assumption that goshawks forage widely throughout their home range. Research conducted on Northern Goshawks suggests that goshawks spend disproportionately more time foraging in mature forests within their home ranges (Bright-Smith and Mannan 1994; Good 1998; Stephens 2001).

Movements and dispersal

It appears that Queen Charlotte Goshawks do not undergo annual large-scale southward migrations (Iverson et al. 1996; McClaren 2003). Rather, males remain closer to nest areas than females and both sexes establish winter home ranges that may include part of their breeding home ranges (Iverson et al. 1996). On Vancouver Island, three females have moved between Vancouver Island, the islands off Vancouver Island's east coast, and the mainland coast (McClaren 2003). It is unknown whether Queen Charlotte Goshawks partake in cyclic massive invasions southward that have been reported for Northern Goshawks (Mueller and Berger 1967; Hofslund 1973; Mueller et al. 1977). Two radio-tagged females on Vancouver Island moved to nest in different nest areas in subsequent years (McClaren 2003). Breeding dispersal ranged from 4–12 km. Minimal information is available for goshawk juvenile dispersal. In southeast Alaska, radio-tagged juveniles ($n = 23$) were relocated between 11.2–161.6 km from natal areas 9–319 days after dispersal (Iverson et al. 1996). On Vancouver Island, fledglings could not be located from the ground or air within 1 week after dispersal (McClaren and Pendergast 2002). These results suggest that fledglings may move large distances from their natal territories immediately after dispersal.

Habitat

Structural stage

5: young forest (under certain conditions, may be used but is generally not preferred)
6: mature forest
7: old forest

A few nests occur in highly productive growing sites in forests in structural stage 5. Nests in these younger structural stages are typically in red alder (*Alnus rubra*) along creek beds within predominantly coniferous forests or in coniferous trees that have multiple leaders (McClaren 1998).

Important habitats and habitat features

Nesting

Queen Charlotte Goshawks appear to nest in a variety of forest types throughout their range and therefore their breeding habitat associations are difficult to characterize (Iverson et al. 1996; Ethier 1999; McClaren 2003). Although varied, the coastal forests goshawks breed in share common characteristics including: 1) >45 years (structural stages 5–7); 2) multi-layered canopies; 3) structurally diverse; 4) canopy closure >50%; 5) large diameter trees for the locale; 6) snags and coarse woody debris; 7) typically not along forest/non-forest edges; 8) not near urban areas; and 9) generally nests are on the lower 2/3 of slopes where slope gradient is <40° (Iverson et al. 1996; Daw et al. 1998; Ethier 1999).

Within these forest stands, goshawks build their nests in several tree species, and typically, nest trees include the largest trees in the stand (Reynolds et al. 1992; Iverson et al. 1996; Ethier 1999). Most often, goshawks breeding in coastal forests select western hemlock (*Tsuga heterophylla)*, Douglas-fir (*Pseudotsuga menziesii*), Sitka spruce (*Picea sitchensis*), and red alder for nest trees at elevations <900 m (Iverson et al. 1996; Ethier 1999; McClaren 2003). On Vancouver Island, Ethier (1999) reported goshawk nest trees were immediately surrounded by forests with lower tree densities and larger dbh than forests outside the nest stands, whereas forest characteristics not immediately around nests but surrounding nests, were denser and had smaller dbh. He suggested goshawks might breed in forests with these characteristics to increase manoeuvrability within the nest stand while increasing their protection from predators with higher tree densities surrounding the nest stand.

Post-fledging

Post-fledging areas are considered important habitat for young goshawks because fledglings are learning to fly and hunt, making them extremely vulnerable to predation during this time (Reynolds et al. 1992; Kennedy et al. 1994; Daw and DeStefano 2001). Post-fledging areas are characterized by an abundance of the habitat attributes critical for goshawk prey (snags, coarse woody debris), and by extensive canopy cover (>50%) which provides protection to fledglings learning to fly and hunt (Reynolds et al. 1992; Kennedy et al. 1994; Daw and DeStefano 2001).

Foraging

Minimal information on the habitat of goshawk kill sites is available for Queen Charlotte Goshawks. Goshawks appear to be opportunistic in their hunting habitats as long as prey is available to them. In Arizona, Beier and Drennan (1997) reported that radio-tagged *A. gentilis atricapillus* were foraging in sites that had a higher canopy closure, greater tree density, and a greater density of large diameter trees than forests that were available to them. Importantly, the areas used by these goshawks for foraging did not have the highest abundance of prey species within their study area; foraging occurred in areas where prey were most available to goshawks because the forest structure was conducive for them to capture prey (Beier and Drennan 1997). It is unknown how important habitat edge zones, subalpine/alpine areas, and estuaries are as foraging habitat for the Queen Charlotte Goshawk. As well, it is unclear how patch size influences the suitability of forests for goshawk foraging habitat. In southeast Alaska, radio-tagged goshawks included beach/forest edge zones in their foraging habitat (Iverson et al. 1996). Although most locations of goshawks on Vancouver Island during the winter occurred in large patches of old-growth forests, some locations occurred in high-elevation forests, subalpine areas, and in estuaries (McClaren 1997, 1998, 1999).

Winter

Winter habitat requirements for the Queen Charlotte Goshawk are unclear. In southeast Alaska and on Vancouver Island, it appears that goshawks are partial migrants, remaining within 10–100 km of their nest. In some years satellite-tagged females on Vancouver Island moved to a separate winter area but in other years expanded their breeding home ranges to include their winter range (Iverson et al. 1996; McClaren 2003). Winter locations from a low-intensity radio telemetry study on Vancouver Island suggest goshawks spend disproportionate amounts of time in mature and old-growth forests throughout the winter (McClaren 1997, 1998, 1999). As well, several locations occurred in high elevation older forests, suggesting goshawks forage on grouse and ptarmigan during the winter. In southeast Alaska, 58% of combined breeding and non-breeding season goshawk habitat use was in very high to moderately productive old-growth forests and 30% of habitat use was in mature sawtimber, scrub forest, and low productivity old-growth forests (Iverson et al. 1996). Habitat use patterns did not significantly differ between the breeding and non-breeding seasons in southeast Alaska (Iverson et al. 1996).

Conservation and Management

Status

The Queen Charlotte Goshawk is on the provincial *Red List* in British Columbia. It is designated as *Threatened* in Canada (COSEWIC 2002).

Summary of ABI status in BC and adjacent jurisdictions (NatureServe Explorer 2002)

BC	AK	Canada	Global
S2B, SZN	S2	N2	G5T2

Trends

Population trends

Population trends are not known in Alaska and British Columbia (Iverson et al. 1996; Cooper and Stevens 2000). Most goshawk studies have focussed on describing goshawk habitat associations rather than on determining their demographic rates. Birth rates for the Queen Charlotte Goshawk, estimated by the number of young fledged/active nest (the number of young in the nest approximately 1 week prior to fledging; Steenhof 1987), was 1.6 ± 0.1 S.E. ($n = 141$ breeding events) on Vancouver Island (McClaren 2003). Mean nest productivity on Vancouver Island varied significantly among years within the same nest areas which suggests that prey and weather are important factors influencing goshawk reproduction (McClaren et al. 2002). Mean nest productivity values could not be calculated for goshawk nests in the Queen Charlotte Islands because sample sizes were too small, but for one to two active nests per year, nest productivity in the Queen Charlotte Islands ranged from 0 to 2 young (Chytyk and Dhanwant 1999). In southeast Alaska, a mean number of two young fledged per nest attempt (Flatten et al. 2001). Adult and juvenile survivorship information is scarce for *A. gentilis laingi*. In southeast Alaska, Iverson et al. (1996) estimated survivorship of radio-tagged adults (sexes combined) to be 0.72 ($n = 39$; 95% CI = 0.56–0.88) between July 1992 and August 1996. They used a staggered-entry Kaplan-Meier estimator (Pollock et al. 1989) for their data analysis (Iverson et al. 1996). The annual survival rate of juveniles has not been estimated for *A. gentilis laingi*. Radio telemetry data from Vancouver Island for adult goshawks suggest that adults have high overwinter mortality rates (McClaren 2003). However, survival estimates on Vancouver Island may be biased high due to the possibility of elevated mortality rates of birds induced by the extra weight from backpack radio transmitters. Although evidence for detrimental effects of backpack transmitters on goshawk survival throughout North America and Europe is lacking, it may be a concern for radio telemetry studies on smaller *A. gentilis laingi*.

Habitat trends

Typically, Queen Charlotte Goshawks breed in mature and old forests throughout their range (Titus et al. 1994; Chytyk et al. 1997; McClaren 2003), which are economically valuable to forest companies for timber harvest. Thus, with the continued harvest of potential goshawk breeding habitat, there will be a shift in forest age and structural stage class distribution, and increased exposure of interior forest areas to edge influences as the landscape becomes more fragmented and human intrusion expands into these forests through access roads. It is predicted that this will decrease the amount of suitable breeding habitat available to *A. gentilis laingi* throughout its range (Iverson et al. 1996; DeStefano 1998; Cooper and Stevens 2000). Reduced age of forest harvesting (i.e., decreased rotation periods) is expected to further reduce the availability of suitable breeding habitat because forests will be harvested before they obtain the structural attributes that characterize goshawk nest stands (DeStefano 1998). Furthermore, older forests may suffer from increased 'natural' disturbances (e.g., fire, wind-throw, snowpress), as they become more fragmented and vulnerable to the natural elements and to human-induced forest fires.

The influence of forest harvesting and natural disturbances on the suitability of foraging habitat for goshawks in the future is less clear. Goshawks may be forced to increase their breeding home range size in order to gather sufficient prey to raise young as landscapes become more fragmented around their nest sites. The influence of forest harvest practices on the abundance and availability of goshawk prey species is less clear because goshawks appear to be opportunistic hunters during the breeding season. However, because Queen Charlotte Goshawks typically do not forage within younger forests, access to most forest prey will be reduced as the overall distribution of forest age class across the landscape becomes younger and a shorter harvest rotation time is practiced. In southeast Alaska, Queen Charlotte Goshawks avoided young forests and clearcuts during radio telemetry studies (Iverson et al. 1996).

Because little information regarding the habitat needs of Queen Charlotte Goshawks in the winter is available, it is difficult to predict future trends for their winter foraging habitat. Regardless, the availability of suitable winter foraging habitat is likely essential for the persistence of Queen Charlotte Goshawk populations because they may be heavily reliant on important prey species during the winter when fewer prey species are available to them. Winter foraging success for goshawks determines the body condition that they enter the breeding season in and therefore, determines whether they initiate breeding within a given year.

Threats

Population threats

Since the early-mid 1900s, Queen Charlotte Goshawk populations do not appear to be threatened by shooting and trapping. Pesticides and other contaminants have not been examined in Queen Charlotte Goshawk populations but Snyder et al. (1973) reported pesticide levels in *A. gentilis atricapillus* populations to be low.

The influence of human disturbances on goshawk populations has not been studied in an experimental framework. However, human disturbances around nest sites appear to have caused *A. gentilis atricapillus* to abandon nests during courtship, incubation, and in the early nestling phase (Boal and Mannan 1994; Squires and Reynolds 1997; Toyne 1997), with fewer effects during the late nestling and fledgling-dependency phases (Toyne 1997). Furthermore, Bosakowski and Speiser (1994) and Bosakowski and Smith (1997) reported *A. gentilis atricapillus* avoided urban areas for nesting. The relationship between human disturbance and the ability for goshawks to nest successfully appears to vary according to an individual's tolerance level. Adults are more sensitive early in the breeding season than they are later on, when they have invested more energy in raising their young.

Habitat fragmentation may result in other raptors better suited to edge habitats such as Red-tailed Hawks (*Buteo jamaicensis*), Great Horned Owls (*Bubo virginianus*), and Barred Owls (*Strix varia*) outcompeting goshawks for nest sites. As well, predation rates on adults and young may increase as nest and roost sites become more accessible to edge dwelling predators such as Great Horned Owls, Raccoons (*Procyon lotor*), American Marten (*Martes americana*), and Fisher (*Martes pennanti*). In fragmented landscapes within Wisconsin, Erdman et al. (1998) documented increased competition by Red-tailed Hawks with *A. gentilis atricapillus* populations, and increased nest predation rates from Great Horned Owls and Fisher. On Vancouver Island, no other species have been observed using known goshawk nest sites, suggesting that competition for nest sites with other species is not high at this time. Iverson et al. (1996) reported nestling predation rates to be low in southeast Alaska. Predation on nestlings and fledglings has been observed on Vancouver Island. However, it is unclear how predation regulates goshawk populations (E.L. McClaren, unpubl. data; McClaren and Pendergast 2002). As well, predation rates on goshawks during their first years are unknown. On the Queen Charlotte Islands, one nest was depredated by a raccoon (P. Chytyk, pers. comm.).

Habitat threats

Breeding, roosting, foraging and winter habitat loss, fragmentation, and degradation from forest harvesting pose the greatest threats to Queen Charlotte Goshawk populations (Iverson et al. 1996; Cooper and Stevens 2000). Although the influence of habitat fragmentation on goshawk populations remains unclear, habitat loss through the conversion of older forests to early seral stages will likely affect goshawk reproduction and survival over time. Risks associated with forest fragmentation and the conversion of older forests to younger ones include:
1) a reduced number of suitable nest areas;
2) decreased prey species abundance and accessibility; 3) increased competition and predation from edge-adapted species; 4) reduced juvenile dispersal and gene flow; 5) increased human access and disturbance; and 6) altered microclimate conditions within interior forests. Altered microclimate conditions may expose adults to inclement weather and influence their thermoregulatory capabilities, reducing their survival directly or their ability to successfully incubate eggs and brood young. For example, North et al. (2000) demonstrated that reproduction in "California" Spotted Owls (*Strix occidentalis occidentalis*) was higher when nest site canopy cover was greater because canopy influenced nest site microclimate.

Legal Protection and Habitat Conservation

The Queen Charlotte Goshawk, its nests and eggs are protected under the provincial *Wildlife Act*. Capture of wild birds for falconry has been closed on Vancouver Island and on the Queen Charlotte Islands since 1994 (Cooper and Stevens 2000). Even prior to the 1994 closure, few Queen Charlotte Goshawks were captured for falconry in British Columbia, as most falconers preferred to take the larger, Northern Goshawk individuals (M. Chutter, pers. comm.).

On Vancouver Island, goshawk nests have been located in Walbran, Strathcona, and Gold/Muchalat Provincial Parks and the Nimpkish Island ecological reserve, and likely occur in several other provincial parks and ecological reserves on Vancouver Island. Several parks throughout the Queen Charlotte Goshawk range consist primarily of unsuitable habitat (i.e., >900 m that is steep open forest canopy or non-forested).

The provisions enabled under the *Forest and Range Practices Act* that may maintain suitable habitat for this species include ungulate winter ranges (UWRs), old growth management areas (OGMAs), wildlife tree retention areas, and riparian management areas. However, the ability of these areas to provide patches that are large enough to be suitable breeding habitat (i.e., 200 ha PFAs) is limited. Preliminary analysis of UWR size on Vancouver Island indicates that roughly <4% of current UWRs are of suitable size for a goshawk PFA (D. Doyle, unpubl. data). Although, these other mechanisms may be useful, particularly when used in conjunction with wildlife habitat areas (WHAs), their stand-alone utility to provide suitable goshawk breeding habitat is limited. They may be used to provide foraging habitat for goshawks around PFAs.

Identified Wildlife Provisions

Sustainable resource management and planning recommendations

Because goshawks have large breeding and winter home ranges and often build multiple nests within breeding areas throughout their lifetime, it may be more effective to address the requirements of this species at the landscape level to ensure that suitable goshawk breeding, foraging, and wintering habitat exists throughout the landscape (i.e., outside of designated WHAs) in addition to maintaining known nest sites. Winter habitat, which is currently not considered in this document, may be equally as important to long-term goshawk persistence as protecting their breeding habitat. However, in the absence of winter habitat data for goshawks, it is difficult to make winter habitat recommendations at this time but should be revisited when data become available.

- Ensure that late structural staged forests (structural stages 5–7) <900 m asl are represented throughout the forested land base so that both established and dispersing goshawks will have an opportunity to breed and forage in favourable habitats.
- Ensure that late structural staged forests exist in large patch sizes equally as often as small patch sizes and that connectivity between late structural staged forest patches is maintained.
- Ensure that suitable breeding habitat for goshawks occurs every 6–8 km, the current goshawk nesting density observed within some areas on Vancouver Island.
- Maximize retention of and connectivity between suitable nesting, post-fledging and foraging habitats.
- Maintain suitable foraging habitat in close proximity to known nests, particularly within the immediate 2200 ha surrounding the PFA. Although foraging areas can be much larger than 2200 ha for goshawks (i.e., goshawks forage throughout their breeding home range), this represents the core foraging area in the breeding season since it is in closest proximity to the PFA.

- Utilize OGMAs, UWRs, and WTR areas to buffer goshawk 200 ha PFAs to protect their integrity and to provide foraging habitat around PFAs.
- Minimize the influence of harvesting adjacent to PFAs to maintain the stand's integrity (e.g., wind firmness).

Wildlife habitat area

Goal

Maintain breeding habitat at known goshawk nests to ensure that breeding pairs may successfully raise their young to dispersal.

Feature

Establish WHAs in areas with known goshawk nest trees. Typically, WHAs should be placed around nesting areas where occupancy and nest productivity patterns are known. Determining re-occupancy and breeding success of goshawk breeding areas is extremely difficult given their use of several alternative nest trees within their breeding area in successive years (Squires and Reynolds 1997). As well, goshawks can be very secretive and difficult to detect using existing survey techniques (McClaren 2001). Because goshawks do not breed every year, a nest area may be inactive one year but active in following years. Thus WHAs should only be removed if the habitat has changed since the establishment of the WHA and is now considered unsuitable goshawk breeding habitat.

Foraging areas within 2200 ha of the PFA should be maintained through coarse filter mechanisms such as UWR, OGMAs, WTR areas, riparian management areas, retention harvesting, and other landscape level planning strategies. When these other mechanism cannot address foraging habitat requirements within 2200 ha of goshawk PFAs, foraging areas (amount to be determined on a site specific basis), can be incorporated within the WHA. This may be required in areas such as the Queen Charlotte Islands where UWR areas are not in place.

Currently, information regarding habitat features that enhance goshawk overwinter survivorship is unavailable and therefore, they cannot be addressed in this document.

Size

Approximately 200 ha but will depend on site-specific factors such as the terrain, habitat distribution, the distribution of OGMAs and UWRs, whether foraging habitat is included within the WHA, and the predicted harvesting regime in future years.

Design

The WHA should include suitable post-fledging habitat (see "Important habitats and habitat features"). The size and shape of the WHA should be determined by the existing habitat and future habitat projections for the breeding habitat and surrounding area. The area around the active nest should be searched for alternative nest trees, plucking posts, and roost sites by a qualified biologist. Ideally, observations and vocalizations of juveniles and their sign during the post-fledgling period should also be used to determine WHA boundaries. Sign includes whitewash, plucking posts, down, and pellets. In addition, consider connectivity with larger stands to prevent stand isolation. Fragmentation may lead to higher predation rates and increased competition for nest sites by edge-adapted predators and competitors. Stand isolation may also threaten the WHA integrity through windthrow.

When sufficient foraging habitat cannot be maintained within the surrounding 2200 ha of the goshawk PFA through alternate mechanisms, it should be incorporated into the WHA. Habitat characteristics and prey transects should be used to determine the boundaries of foraging areas within the WHA.

Manage the PFA as the core area and foraging habitat (if included) as the management zone.

General wildlife measures

Goals

1. Prevent disturbance and abandonment of breeding goshawks.
2. Maintain important breeding and foraging habitat features within core area (PFA).
3. When foraging habitat is included within WHA, maintain suitable foraging habitat and habitat features.

Measures

Access

- Do not construct roads within core area.

Harvesting and silviculture

- Do not harvest or salvage (e.g., cedar) within core area.
- Develop a management plan for harvesting and road development within the management zone that is consistent with the general wildlife measure goals.
- Do not commercial thin within core area. Commercial thinning may occur within the management zone provided the activities promote the structural characteristics of forests for goshawk foraging (e.g., low density thinning of young seral stages to promote older structural attributes).

Pesticides

- Do not use pesticides.

Additional Management Considerations

Minimize disturbance when working adjacent to a WHA between 15 February and 1 September. In general, avoid blasting, road construction, helicopter activity or other prolonged disturbance.

Information Needs

1. Relationship between habitat components and goshawk reproduction and survival. These include the minimum patch size of PFAs and degree of surrounding landscape fragmentation that maintains successful (minimum one young fledged) occupancy by breeding goshawks and breeding over time.
2. Influence of forest harvest practices on goshawk prey species abundance/availability during the breeding and non-breeding seasons and ability of forest enhancement techniques (e.g., thinning) to improve younger forests for goshawk breeding and foraging areas.
3. Goshawk winter habitat associations and prey use.

Cross References

Great Blue Heron, Marbled Murrelet, "Queen Charlotte" Hairy Woodpecker, "Vancouver Island" Northern Saw-whet Owl

References Cited

Alaska Department of Fish and Game (ADFG). 1996. Goshawk ecology and habitat relationships on the Tongass National Forest. 1995 field season progress report. Alaska Dep. Fish Game, Div. Wildl. Conserv., U.S. Dep. Agric. For. Serv., and U.S. Fish Wildl. Serv., Juneau, Alaska.

American Ornithologists' Union (AOU). 1957. Check-list of North American birds. 5th ed. Am. Ornith. Union, Baltimore, Md. 691 p.

Beebe, F.L. 1974. Field studies of the Falconiformes of British Columbia. B.C. Prov. Mus., Victoria, B.C. Occas. Pap. No. 17.

Beier, P. and J.E. Drennan. 1997. Forest structure and prey abundance in foraging areas of northern goshawks. Ecol. Appl. 7:564–571.

Bloxton, T. In prep. M.Sc. thesis. Univ. Wash., Seattle, Wash.

Boal, C.W. and R.W. Mannan. 1994. Northern goshawk diets in ponderosa pine forests on the Kaibab Plateau. Stud. Avian Biol. 16:97–102.

Bond, R.M. and R.M. Stabler. 1941. Second-year plumage of the goshawk. Auk 58:346–349.

Bosakowski, T. and D.G. Smith. 1997. Distribution and species richness of a forest raptor community in relation to urbanization. J. Raptor Res. 31:26–33.

Bosakowski, T. and R. Speiser. 1994. Macrohabitat selection by nesting northern goshawks: implications for managing eastern forests. Stud. Avian Biol. 16:46–49.

Bright-Smith, D.J. and R.W. Mannan. 1994. Habitat use by breeding male northern goshawks in northern Arizona. Stud. Avian Biol. No. 16:58–65.

Chytyk, P., J. Cooper, and K. Dhanwant. 1997. 1997 northern goshawk population inventory of the Queen Charlotte Islands Haida Gwaii; Pre-nesting standwatch surveys. Draft report prepared for B.C. Min. Environ., Lands and Parks, Smithers, B.C.

Chytyk, P. and K. Dhanwant. 1999. 1998 Northern Goshawk (*Accipiter gentilis laingi*) population inventory of the Queen Charlotte Islands/Haida Gwaii. Report for B.C. Min. Environ., Lands and Parks, Smithers, B.C. Unpubl. 41 p.

Committee on the Status of Endangered Wildlife in Canada (COSEWIC). 2002. Canadian Species at Risk. www.speciesatrisk.gc.ca

Cooper, J.M. and V. Stevens. 2000. A review of the ecology, management and conservation of the northern goshawk in British Columbia. B.C. Min. Environ., Lands and Parks, Victoria, B.C. Wildl. Bull. B-101.

Daw, S.K. and S. DeStefano. 2001. Forest characteristics of northern goshawk nest stands and post-fledgling areas in Oregon. J. Wildl. Manage. 65:59–65.

Daw, S.K., S. DeStefano, and R.J. Steidl. 1998. Does survey method bias the description of Northern Goshawk nest-site structure? J. Wildl. Manage. 62:1379–1384.

DeStefano, S. 1998. Determining the status of Northern Goshawks in the west: is our conceptual model correct? J. Raptor Res. 32:342–348.

Detrich, P.J. and B. Woodbridge. 1994. Territory fidelity, mate fidelity, and movements of color-marked northern goshawks (*Accipiter gentilis*) in the southern Cascades of California. Stud. Avian Biol. 16:130–132.

Dewey, S.R. and P.L. Kennedy. 2001. Effects of supplemental food on parental care strategies and juvenile survival of northern goshawks. Thesis. Colorado State Univ., Fort Collins, Colo.

Doyle, F.I. and T. Mahon. 2000. Inventory of the northern goshawk (*Accipiter gentilis*) in the Kispiox Forest District. B.C. Min. Environ., Lands and Parks, Smithers, B.C.

Erdman, T.C., D.F. Brinker, J.P. Jacobs, J. Wilde, and T.O. Meyer. 1998. Productivity, population trend, and status of northern goshawks, *Accipiter gentilis atricapillus*, in northeastern Wisconsin. Can. Field-Nat. 112:17–27.

Ethier, T.J. 1999. Breeding ecology and habitat of northern goshawks (*Accipiter gentilis laingi*) on Vancouver Island: a hierarchical approach. M.Sc. thesis. Univ. Victoria, Victoria, B.C.

Flatten, C., K. Titus, and R. Lowell. 2001. Northern goshawk population monitoring, population ecology and diet on the Tongass National Forest. Alaska Dept. of Fish and Game. Juneau, Alas.

Gavin, T.A. and B. May. 1995. Genetic variation and taxonomic status of northern goshawks in Arizona: implications for management. Arizona Game and Fish. Final Rep. (Draft).

Good, R.E. 1998. Factors affecting the relative use of northern goshawk (*Accipiter gentilis*) kill areas in southcentral Wyoming. Thesis. Univ. Wyoming, Laramie, Wyo.

Hofslund, P.B. 1973. An invasion of goshawks. Raptor Res. 7:107–108.

Iverson, G.C., G.D. Hayward, K. Titus, E. Degayner, R.E. Lowell, C.D. Crocker-Bedford, F.P. Schempf, F. Philip, and J. Lindell. 1996. Conservation assessment of the northern goshawk in southeast Alaska. U.S. Dep. Agric. For. Serv., Pac. Northwest Res. Stn., PNW-GTR-387.

Johnson, D.R. 1989. Body size of northern goshawks on coastal islands of British Columbia. Wilson Bull. 101(4):637–639.

Keane, J.J. and M.L. Morrison. 1994. Northern Goshawk ecology: effects of scale and levels of biological organization. Stud. Avian Biol. 16:3–11.

Kennedy, P.L., J.M. Ward, G.A. Rinker, and J.A. Gessaman. 1994. Post-fledging areas in Northern Goshawk home ranges. Stud. Avian Biol. 16:75–82.

Kenward, R.E., V. Marcstrom, and M. Karlbom. 1993. Post-nestling behavior in goshawks, *Accipiter gentilis*: I. The causes of dispersal. Anim. Behav. 46:365–370.

Lewis, S.B. 2001. Breeding season diet of northern goshawks in southeast Alaska with a comparison of techniques used to examine raptor diet. M.Sc. thesis. Boise State Univ., Boise, Idaho.

Mahon, T. and F.I. Doyle. 2001. Inventory of the northern goshawk in the Lakes Forest District. Annual report 2000/2001. B.C. Min. Environ., Lands and Parks, Smithers, B.C.

McClaren, E. 1997. "Queen Charlotte" goshawk (*Accipiter gentilis laingi*) population inventory summary for Vancouver Island, British Columbia (1996/1997). B.C. Min. Environ., Lands and Parks, Nanaimo, B.C.

_____. 1998. "Queen Charlotte" goshawk (*Accipiter gentilis laingi*) population inventory summary for Vancouver Island, British Columbia (1997/1998). B.C. Min. Environ., Lands and Parks, Nanaimo, B.C.

_____. 1999. Queen Charlotte goshawk (*Accipiter gentilis laingi*) population inventory summary for Vancouver Island, British Columbia (1998/1999). B.C. Min. Environ., Lands and Parks, Nanaimo, B.C.

_____. 2000. Northern goshawk (*Accipiter gentilis laingi*) population inventory summary for Vancouver Island, British Columbia (1999/2001). B.C. Min. Environ., Lands and Parks, Nanaimo, B.C.

_____. 2001. Factors influencing northern goshawk detectability and reproduction on Vancouver Island, B.C. Thesis. Colorado State Univ., Fort Collins, Colo.

_____. 2003. Northern Goshawk (Accipiter gentilis laingi) population inventory summary for Vancouver Island, British Columbia 1994–2002. Min. Water, Land and Air Protection, Nanaimo, B.C.

McClaren, E.L., P.L. Kennedy, and S.R. Dewey. 2002. Do some northern goshawk nest areas consistently fledge more young than others? Condor 104:343–352.

McClaren, E.L. and C.L. Pendergast. 2002. Northern goshawk (*Accipiter gentilis laingi*) post-fledging area size estimation on Vancouver Island, B.C. B.C. Min. Water, Land and Air Protection., Nanaimo, B.C.

McGowan, J.D. 1975. Distribution, density, and productivity of goshawks in Interior Alaska. Alaska Dep. Fed. Aid Wildl. Restor., Juneau, Alaska. Proj. Rep. W-17-4, W-17-5, W-17-6, Job 10.6R. 31 p.

Mueller, H.C. and D.D. Berger. 1967. Some observations and comments on the periodic invasions of goshawks. Auk 84:183–191.

Mueller, H.C., D.D. Berger, and G. Allez. 1977. The periodic invasions of goshawks. Auk 94:652–663.

National Geographic Society (NGS). 1999. Field guide to the birds of North America. 3rd ed. Washington, D.C.

NatureServe Explorer. 2002. An online encyclopaedia of life. Version 1.6. NatureServe. Arlington, VA. Available at http://www.natureserve.org/explorer/

North, M., G. Steger, R. Denton, G. Eberlein, T. Munton, and K. Johnson. 2000. Association of weather and nest-site structure with reproductive success in California spotted owls. J. Wildl. Manage. 64:797–807.

Palmer, R.S. 1988. Northern goshawks. *In* Handbook of North American birds. Vol. 4. Diurnal raptors. R.S. Palmer (editor). Yale Univ. Press, New Haven, Conn., pp. 355–378.

Pollock, K.H., S.R. Winterstein, and M.J. Conroy. 1989. Estimation and analysis of survival distributions for radio-tagged animals. Biometrics 45:99–109.

Reynolds, R.T. 1983. Management of western coniferous forests habitat for nesting accipiter hawks. U.S. Dep. Agric. For. Serv., Rocky Mtn. Forest Range Exp. Stn., Fort Collins, Colo., Gen. Tech. Rep. RM-102.

Reynolds, R.T., R.T. Graham, M.H. Reiser, R.L. Bassett, P.L. Kennedy, D.A. Boyce, Jr., G. Goodwind, R. Smith, and E.L. Fisher. 1992. Management recommendations for the northern goshawk in the southwestern United States. U.S. Dep. Agric. For. Serv., Fort Collins, Colo., Gen. Tech. Rep. RM-217.

Reynolds, R.T. and S.M. Joy. 1998. Distribution, territory occupancy, dispersal, and demography of northern goshawks on the Kaibab Plateau, Arizona. Ariz. Game and Fish. Heritage Proj. No. I94045.

Reynolds, R.T., E.C. Meslow, and H.M. Wight. 1982. Nesting habitat of coexisting *Accipiter* in Oregon. J. Wildl. Manage. 46:124–138.

Sibley, D.A. 2000. National Audobon Society the Sibley guide to birds. Alfred A. Knopf, Inc., New York, N.Y.

Snyder, N.F.R., H.A. Snyder, J.L. Lincer, and R.T. Reynolds. 1973. Organochlorines, heavy metals, and the biology of North American *accipiters*. BioScience 23:300–305.

Squires, J.R. and R.T. Reynolds. 1997. Northern goshawk (*Accipiter gentilis*). *In* Birds of North America, No. 298. A. Poole and F. Gill (editors). Acad. Nat. Sci., Philadelphia, Penn., and Am. Ornith. Union, Washington, D.C.

Steenhof, K. 1987. Assessing raptor reproductive success and productivity. *In* Raptor management techniques manual. B.A. Giron Pendleton, B.A. Milsap, K.W. Cline, and D.M. Bird (editors). Sci. Tech. Ser. No. 10, Natl. Wildl. Fed., Washington, D.C., pp. 157–170.

Stephens, R.M. 2001. Winter ecology of northern goshawks in the Uinta Mountains. Thesis. Univ. Wyoming, Laramie, Wyo.

Taverner, P.A. 1940. Variation in the American goshawk. Condor 42:157–160.

Titus, K., C.J. Flatten, and R.E. Lowell. 1994. Northern goshawk ecology and habitat relationships on the Tongass National Forest (goshawk nest sites, food habits, morphology, home range, and habitat data). First Annu. Proj. Rep. U.S. Dep. Agric. For. Serv. and Alaska Dep. Fish Game, Juneau, Alaska. Contract 43-0109-
3-0272.

Toyne, E.P. 1997. Nesting chronology of northern goshawks (*Accipiter gentilis*) in Wales: implications for forest management. Forestry: 121–126.

Webster, J.D. 1988. Some bird specimens from Sitka, Alaska. Murrelet 69:46–48.

Whaley, W.H. and C.M. White. 1994. Trends in geographic variation of Cooper's hawk and northern goshawk in North America: a multivariate analysis. West. Found. Vertebr. Zool. 5(3):161–209.

Personal Communications

Chutter, M. 2002. Min. Water, Land and Air Protection, Victoria, B.C.

Chytyk, P. 2001. Manning, Cooper and Associates, Victoria, B.C.

Talbot, S. 2002. U.S. Geological Survey. Anchorage, Alas.

SAGE THRASHER

Oreoscoptes montanus

Original[1] prepared by Martin Gebauer

Species Information

Taxonomy

The Sage Thrasher is the only species in the genus *Oreoscoptes* and no subspecies are recognized (Cannings 1998). It is likely more closely related to the mockingbirds of the genus *Mimus* than to thrashers in the genus *Toxostoma* (Reynolds et al. 1999).

Description

White wing bars, a white-cornered tail, and distinctive yellow eyes are distinguishing field marks of the Sage Thrasher. Plumage colouration is greyish-brown above and boldly streaked below. Worn late-summer birds show much less streaking. The bill is rather thrush-like and the tail is short for a thrasher. A poorly defined pale eyebrow line is also present (Godfrey 1986; NGS 1999).

Distribution

Global

The Sage Thrasher breeds from extreme south-central British Columbia, central Idaho, and south-central Montana south through the Great Basin to north-eastern Arizona, west-central and northern New Mexico, northern Texas, and western Oklahoma (Reynolds et al. 1999). It has also bred in southeastern Alberta and southern Saskatchewan (Godfrey 1986). The Sage Thrasher winters from central California, southern Nevada, northern Arizona, central New Mexico, and central Texas south to Baja Mexico and central Mexico (Howell and Webb 1995; Campbell et al. 1997; Reynolds et al. 1999).

British Columbia

In British Columbia, the Sage Thrasher is still reported annually from the Chopaka border crossing along Nighthawk Road, in the Richter Pass/Kilpoola Lake area, and almost annually from White Lake near Oliver (Nelson 1993; Cannings 2000). Singing birds have been reported from Vernon, the Thompson Valley at Lac du Bois, the Fraser Valley near Spences Bridge, and recently east of Oliver (Cannings 2000). A recent interesting record was of an old nest found west of Cache Creek along the Fraser River (Campbell et al. 1997), the first indication of breeding in this area.

Forest region and district

Southern Interior: Okanagan Shuswap

Ecoprovinces and ecosections

SOI: NOB, OKR, PAR, SOB, THB

Biogeoclimatic units

BG: xh1, xh2
IDF: xh1
PP: xh1, xh2a

Broad ecosystem units

AB, BS, CF, DP, SS

Elevation

300–500 m

Life History

Diet and foraging behaviour

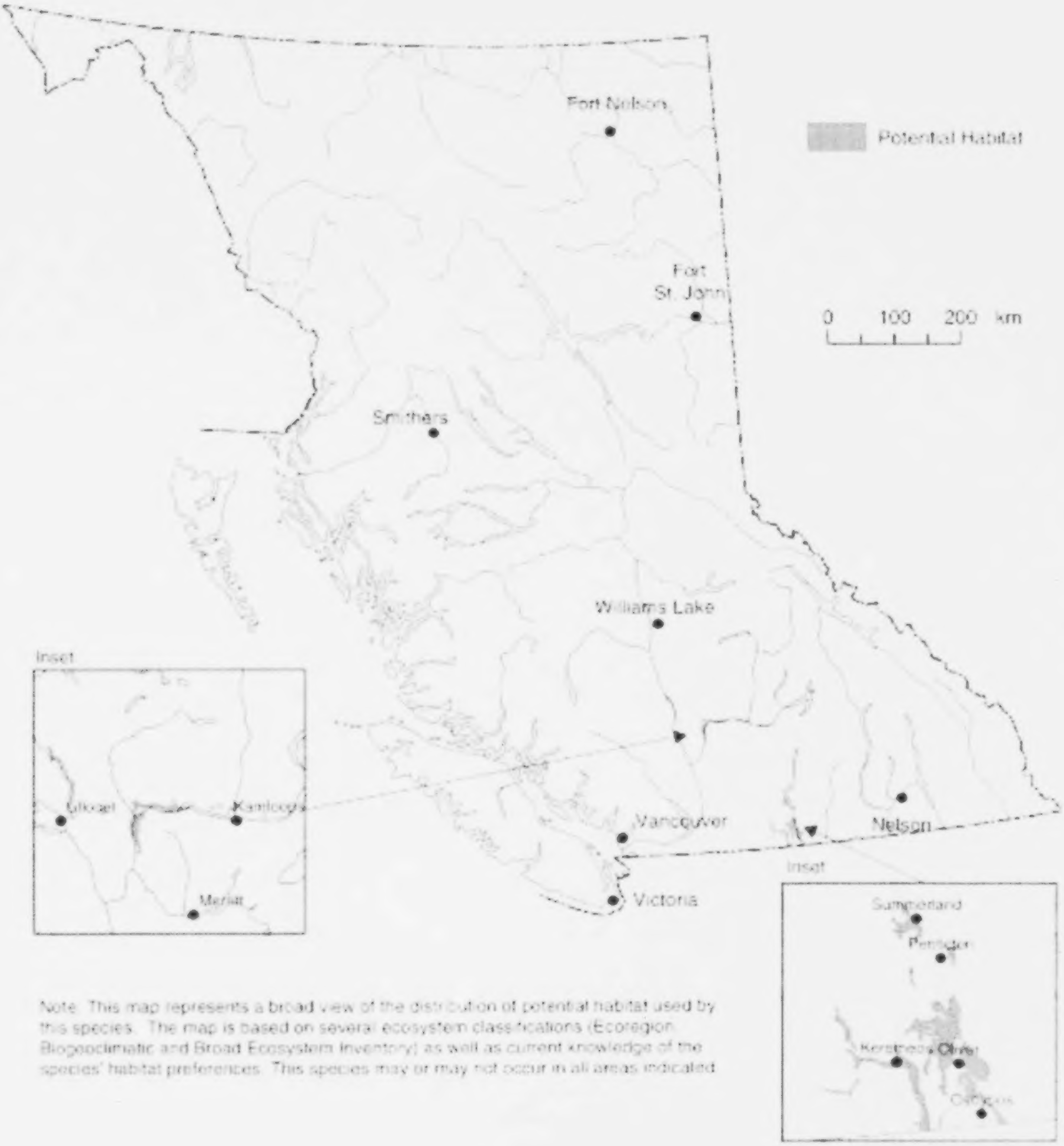
Since the diet consists of insects and other terrestrial invertebrates, as well as small fruits, especially berries (Dobkin 1992; Paige and Ritter 1999), the Sage Thrasher is considered to be an opportunistic feeder rather than a specialist (Reynolds et al. 1999).

---

[1] Volume 1 account prepared by R. Millikin.

Sage Thrasher

(Oreoscoptes montanus)


Fort Nelson
Potential Habitat
Fort St. John
0 100 200 km
Smithers
Williams Lake
Inset
Lillooet
Kamloops
Merritt
Vancouver
Nelson
Victoria
Inset
Summerland
Penticton
Keremeos
Oliver
Osoyoos

Note: This map represents a broad view of the distribution of potential habitat used by this species. The map is based on several ecosystem classifications (Ecoregion, Biogeoclimatic and Broad Ecosystem Inventory) as well as current knowledge of the species' habitat preferences. This species may or may not occur in all areas indicated.

Sage Thrashers forage on the ground and glean from foliage (Dobkin 1992). They have been observed feeding at an ant mating swarm, digging for crickets and eating eggs, eating locusts and ants, eating saskatoon (*Amelanchier alnifolia*) berries, and breaking skin and eating from ripe grapes (Bent 1948; Stephens 1985; Nelson 1993; Blood 1995, Reynolds et al. 1999). Stephens (1985) provides a detailed analysis of Sage Thrasher diet in central Washington.

Reproduction

In British Columbia, dates for 21 clutches ranged from 1 June to 28 July, with 65% between 15 and 22 June. Clutch size ranged from one to five eggs with 71% having four or five eggs (Campbell et al. 1997). Reynolds (1981), Reynolds and Rich (1978), and Gooding (1970, cited by Reynolds et al. 1999) have reported average clutches of 3.5, 3.8, and 4.1, respectively. Clutches of up to seven eggs have been reported (Bent 1948). Incubation period ranges from 13 to 17 days with a mean of 15 days (Reynolds and Rich 1978; Reynolds 1981; Ehrlich et al. 1988). In British Columbia, dates for 15 broods ranged from 18 June to 11 August (Campbell et al. 1997). Brood sizes ranged from one to five young with 87% having two to four young. The nestling period generally ranges from 10 to 14 days (Reynolds 1981; Ehrlich et al. 1988; Campbell et al. 1997). Double brooding occurs occasionally (Reynolds 1981; Cannings et al. 1987).

Cowbird parasitism was not found in 24 nests with eggs or young in British Columbia (Campbell et al. 1997), and has only been reported once in other areas (Friedmann and Kiff 1985), likely because Sage Thrashers reject cowbird eggs quickly (Rich and Rothstein 1985).

Site fidelity

No information on nest site fidelity is available; however, Sage Thrashers regularly occur at several sites.

Home range

Mean territory sizes for two successive years in southeastern Idaho were 1.14 and 1.86 ha, respectively, with density estimates of 0.88 and 0.54 birds/ha, respectively (Reynolds 1981). Reynolds and Rich (1978) found territory sizes in Idaho ranging from 0.64 to 1.64 ha. In Washington, density estimates were 0.204 birds/ha in 1988, 0.212 in 1989, and 0.09 in 1990 (Dobler et al. 1996). In east-central Nevada, density estimates ranged between 0.12 and 0.4 birds/ha between 1981 and 1983 (Medin 1992). In the south Okanagan, territory sizes of 6–8 ha have been reported (R. Millikin, pers. comm., cited by Campbell et al. 1997).

Movements and dispersal

Migrants arrive in the Okanagan Valley as early as the first week of April, but typically in May or even early June (Campbell et al. 1997). Sage Thrashers appear to leave in late August or early September with the latest date being 29 September (Cannings et al. 1987; Cannings 2000).

No information is available on initial dispersal of birds from natal sites (Reynolds et al. 1999).

Habitat

Structural stage

2: herb
3a: low shrub

Important habitats and habitat features

Nesting

The Sage Thrasher is almost entirely dependent on sagebrush habitats during the breeding season (Braun et al. 1976; McAdoo et al. 1989; Knick and Rotenberry 1995a; Dobler et al. 1996), although breeding birds are occasionally noted in other shrub-steppe habitats and antelope-brush (*Purshia tridentata*) (Reynolds et al. 1999). Generally, abundance of breeding birds is positively correlated with sagebrush cover and negatively correlated with annual grasses (Wiens and Rotenberry 1981; Reynolds et al. 1999). Sites with medium-sized sagebrush (30–60 cm high), with some larger sagebrush (>1 m) for nesting are preferred (Rich 1980; Wiens and Rotenberry 1981; Castrale 1982; Petersen and Best 1991; Campbell et al. 1997; Paige and Ritter

1999). Shrub cover >15–20% may be important (Cannings 2000).

Nineteen nests in British Columbia ranged from 8 to 154 cm off the ground (Campbell et al. 1997) compared with most nests in south-central Idaho which were placed on the ground (Reynolds and Rich 1978; Rich 1978). Nests found by R. Millikin (pers. comm.) in the south Okanagan were a minimum of 26 cm off the ground. R. Millikin (pers. comm., cited by Campbell et al. 1997) found that sagebrush (*Artemesia tridentata*) selected by thrashers in the south Okanagan was larger (i.e., larger total height and width) than surrounding shrubs and larger than randomly selected shrubs on census transects, and that the mean density of sagebrush canopy at nest sites was approximately 70%. For nesting, individuals select shrubs that have the greatest total height (mean of 132 cm) and crown width (mean of 168 cm) and have a full crown (i.e., with no gaps). In several studies in Idaho, mean nest shrub height averaged from 69 to 89 cm with nests placed at 10–30 cm from the ground (Rich 1980; Reynolds 1981) and in larger shrubs than are available at random (Petersen and Best 1991). Castrale (1982) also found Sage Thrashers in habitat patches containing the largest shrubs, whereas McAdoo et al. (1989) did not find a correlation between Sage Thrasher abundance and shrub height. The most important factor in nest placement seems to be the amount of cover above the nest; nests are placed just below the densest vegetation in vertical profile (Rich 1978; Rich 1980; Reynolds 1981; Castrale 1982). Petersen and Best (1991) found that all nest bushes were 75% or more live and had few gaps in either the vertical or the horizontal profile. Large, continuous areas of sagebrush also appear to be important (MELP 1998).

The primary plant species used for nesting is sagebrush (Campbell et al. 1987). Other nest tree species reported in the Okanagan included an orchard peach tree (Cannings et al. 1987), red hawthorn (*Crateagus columbiana*), and saskatoon (*Amelanchier alnifolia*) (Campbell et al. 1997). Rabbitbrush, (*Ericameria bloomeri*) antelope-brush, and juniper (*Juniperus* spp.)have also been used for nesting in the United States (Blood 1995). The nest is a bulky structure comprised of sagebrush twigs, rootlets, bark strips, and plant stems, and lined with strips of sagebrush bark, fine grasses, horse and cattle hair, and fine rootlets (Cannings et al. 1987; Campbell et al. 1997). Several nests in the Okanagan were placed in trees with branches broken horizontally and nests were placed so that these branches would shade the nest from the sun (Cannings et al. 1987). R. Millikin (pers. comm.) found that cover above the nest was a critical habitat attribute. Shade platforms, constructed of twigs, are sometimes placed over the nest. A nest at White Lake had no shade platform when it was found with a clutch of five eggs, but 8 days later, when five young were present, a platform had been constructed with the addition of a twig "porch" as well (Cannings et al. 1987).

Foraging

During the breeding season, the Sage Thrasher breeds almost entirely in sagebrush habitats. During the non-breeding season, it has been observed feeding on residential lawns, orchards, and intertidal habitats in coastal areas (Cannings 1995; Campbell et al. 1997).

Conservation and Management

Status

The Sage Thrasher is on the provincial *Red list* in British Columbia. It is designated as *Endangered* in Canada (COSEWIC 2002). (See Summary of ABI status in BC and adjacent jurisdictions at top of next page.)

Trends

Population trends

In British Columbia, Sage Thrasher populations have fluctuated over the last 100 years (Cannings et al. 1987). Before 1914, several pairs were present at White Lake, whereas in the 1920s, it appeared to be absent from that location (Cannings et al. 1987). During 1931, an estimated 15 pairs were present at White Lake (Darcus 1932). The highest count at

Summary of ABI status in BC and adjacent jurisdictions (NatureServe Explorer 2002)

AB	BC	CA	ID	MT	OR	WA	Canada	Global
S1B	S1B	S5	S5B, S2N	S5B, S2N	S4	S3B, S2N	N1B	G5

White Lake in the past 35 years was five pairs in 1969; they have averaged one to two pairs since then (Cannings et al. 1987). At Chopaka, an estimated 6–10 pairs nest annually, and several pairs are thought to nest south of Kilpoola Lake (Campbell et al. 1997; Cannings 2000). In 1990, the Chopaka, Richter Pass, Kilpoola Lake, and White Lake areas were thoroughly searched for 6 days but only four birds were found (Preston 1990). In 1991, the same area was searched and 11 Sage Thrashers were found singing (Cannings 2000). In 1993, single active nests were found at Kilpoola and Chopaka and seven adults were censused (R. Millikin, pers. comm.). In 1994, no active nests were located after extensive surveys and only four adults were censused. At its historical high, the British Columbia population of Sage Thrashers may have been as high as 30 or more pairs (Cannings 2000).

Sage Thrasher populations appear to be stable across their range. Regional significant population increases (between 1966 and 1999) have been noted in California (3.4%) on Breeding Bird Surveys (Sauer et al. 2000). Populations appear to be increasing in Colorado and Oregon (Sauer et al. 2000). Peripheral populations in Washington are on the decline because of large-scale habitat losses (Reynolds et al. 1999). Why Sage Thrashers are doing well in areas where other sagebrush obligates such as Sage Grouse (*Centrocercus urophasianus*) and Brewer's Sparrow (*Spizella breweri*) are declining is not known, but Sage Thrashers may tolerate habitat fragmentation better than other species (Knick and Rotenberry 1995b). In one area where sagebrush was sprayed and shrub cover was reduced from 28 to 4% and grass cover increased, Sage Thrashers declined only slightly in the short term (Weins and Rotenberry 1985).

Habitat trends

The area of suitable habitat available in British Columbia has slowly been declining over the past 70 years. In all, there has probably been <50% of habitat lost in the past 70 years, but development pressures on remaining highly suitable habitat, particularly in the Richter Pass and White Lake areas, are very high (Cannings 1995). Of the 27 478 ha of suitable habitat (much of which is suboptimal) in the south Okanagan and Similkameen valleys, 42% is private land, 28% Indian Reserve, 26% provincial Crown land, and 4% conservation lands (MELP 1998). Vineyard developments on the Inkameep Indian Reserve (Osoyoos Indian Reserve) have destroyed several hundred hectares of shrub-steppe habitat on the east side of Osoyoos Lake. This area is probably not optimal for Sage Thrasher since it is a mix of antelope-brush, big sagebrush (*Artemisia tridentata*), and rabbitbrush (*Ericameria nauseosus*), but thrashers have nested there in the past (Cannings 2000). Further agricultural, housing, and tourism developments threaten several more hundred acres of habitat in the reserve, although about 500 ha is proposed for protection. Urbanization and other developments are also impacting lowland habitats in other areas. Range improvement programs attempting to eradicate sagebrush through burning or mowing are impacting habitat quality in some areas.

Loss of suitable habitat in Washington State is of concern to Canadian populations. Approximately half of the historic area of sagebrush steppe in the United States has been lost to intensive agriculture, and only half of the remaining portion is in good condition (Vander Haegen et al. 1999; Cannings 2000).

Threats

Population threats

Small breeding population with a restricted distribution and unsecured habitat (Fraser et al. 1999).

Pesticide spraying may impact some populations. In the United States, local declines of grassland birds have been potentially linked to grasshopper control programs using pesticides (Paige and Ritter 1999). In shrub-steppe habitats in southern Idaho, Howe et al. (1996) found that malathion application had no observable direct effects, and only marginal indirect effects, through food-base reduction, on Brewer's Sparrow and Sage Thrasher nestling growth and survival. George et al. (1995) noted that pesticide treatments for grasshopper control had little effect on breeding bird communities in western rangelands.

Eggs and young are lost as a result of large mammalian predators, snakes, birds, and small mammals (Rotenberry and Wiens 1989; Reynolds et al. 1999). Rotenberry and Wiens (1989) considered Gopher Snakes (*Pituophis melanoleucus*) to be the principal predator of shrub-steppe breeding birds in the northern Great Basin.

Habitat threats

The primary limiting factor for Sage Thrasher in Canada is the loss, alteration, or degradation of sagebrush habitats. Loss of sagebrush habitat to agriculture, strip mining, and residential development in the United States (Braun et al. 1976), conversion to wheatfields in Washington State (Weber 1980), and agricultural development of dryland farming areas in Alberta (Cannings 2000) has caused great concern for Sage Thrasher using these environments. Complete replacement of native sagebrush habitat with crested wheatgrass (*Agropyron cristatum*) eliminates this species (Reynolds and Trost 1980, 1981). Even removal of only large sagebrush in breeding habitats can limit utilization by thrashers (Castrale 1982). Generally, land development activities that reduce sagebrush cover below 10% over large areas likely negatively affect Sage Thrashers (Braun et al. 1976).

Continued loss of sagebrush-steppe habitats in British Columbia is the primary threat to Sage Thrasher populations. Urbanization and development, particularly the rapid expansion of vineyards in the south Okanagan, housing developments in the Richter Pass area (Preston 1990), and sagebrush removal for improving range, are the greatest threats to sagebrush habitats. Heavy grazing pressure may affect Sage Thrasher populations negatively (Bradford et al. 1998), but thrashers are generally less sensitive to grazing pressure than other shrub-steppe bird species (Reynolds and Trost 1981; Kantrud and Kologiski 1982). Saab et al. (1995) reported several studies where heavy grazing resulted in a positive response in Sage Thrasher abundance. Historically, intensive range management programs, such as burning, mowing, herbiciding, and planting with crested wheatgrass, negatively impacted sagebrush habitats and the birds using these areas (Reynolds and Trost 1981; Wiens and Rotenberry 1985; Knick and Rotenberry 2000).

Fires may pose a threat to Sage Thrasher in terms of habitat loss, since sagebrush does not resprout after being burned (Castrale 1982). Kerley and Anderson (1995) found that burned areas still lacked thrashers 9 years after a fire, and herbicided areas still had suppressed thrasher populations 22 years after treatment. Petersen and Best (1987) found that Sage Thrasher abundance was unaffected by prescribed burning which resulted in a mosaic of burned and unburned areas in southeastern Idaho. The spread of cheatgrass (*Bromus tectorum*) has had a negative effect on Sage Thrasher populations through its influence on fire regimes in western grasslands (Knick and Rotenberry 1997). Cheatgrass, an annual species, tends to occur in large monocultures that are highly flammable, increasing the spread of fire and loss of sagebrush and other shrubs and accelerating the spread of annuals such as cheatgrass (Paige and Ritter 1999).

Potential effects of grazing include trampling of sagebrush plants by livestock.

Legal Protection and Habitat Conservation

The Sage Thrasher, its nests, and its eggs are protected in Canada under the federal *Migratory Birds Convention Act*, and in British Columbia, by the provincial *Wildlife Act*.

According to MELP (1998), only 4% (i.e., 1263 ha) of potential Sage Thrasher habitat is currently designated as conservation lands. Protected areas in the south Okanagan include the Nature Trust of British Columbia lands at White Lake. A number of new protected areas have been announced in the south Okanagan through the Okanagan-Shuswap Land and Resource Management Plan process. Some of the more important proposed parks for Sage Thrasher include White Lake Grasslands and South Okanagan Grasslands. Riparian and biodiversity guidelines under the results based code provide some protection of habitat for Sage Thrasher.

Identified Wildlife Provisions

Strategic management recommendations

- Protection of large areas of continuous sagebrush-steppe habitats is the most important approach required for recovery. Increasing the health of sagebrush-dominated rangelands, and providing suitable nesting habitat is essential in maintaining and increasing populations of Sage Thrasher in British Columbia. Protecting and enhancing these habitats will also benefit other sagebrush-obligate species such as the Sagebrush Brewer's Sparrow and Great Basin Pocket Mouse, and will address overall biodiversity objectives for the region.
- Since population trends of Sage Thrasher in Washington State will likely be reflected in trends in the Canadian population, recovery plans must be co-ordinated with recovery teams or responsible agencies in Washington State.
- Incorporate WHAs for the Sage Thrasher into grassland networks managed to maintain natural grassland communities. Adjacent wetlands and moist gullies, and a substantial proportion of remaining late-seral sagebrush communities should also be included in grassland networks.

Wildlife habitat area

Goals

Maintain suitable nesting habitat for multiple pairs.

Feature

Establish WHAs in areas with breeding densities of one or more pairs and selected high suitability historic breeding sites.

Size

Typically between 10 to 100 ha of shrub-steppe habitats, or up to 200 ha of discontinuous habitat.

Design

A WHA should include sagebrush-dominated shrub-steppe habitats with a mosaic of habitat attributes including a low amount of bare ground (10–20%), moderate densities of shrubs (10–30%), and clumps of big sage (2–10 shrubs >1 m in height).

General wildlife measures

Goals

1. Maintain the integrity of nesting habitat by retaining density and structure of sagebrush habitat.
2. Minimize fires and other activities that remove 100% shrub cover.

Measures

Access

- Do not construct roads unless there is no other practicable option.

Pesticides

- Do not use pesticides.

Range

- Plan livestock grazing to minimize crown breakage, maintain the desired sagebrush cover.
- Protect large sagebrush patches during weed control programs.
- Maintain clumps of large (>0.9 m in height and >1.1 m in width) living sagebrush.
- Do not place livestock attractants within WHA.

Additional Management Considerations

Maintain low-elevation, dry shrub-steppe. Avoid widespread range burning and clearing of native shrubs such as sagebrush and antelope-brush in important breeding areas.

Avoid high intensity grazing that negatively impacts shrubs and reduces shrub cover required by Sage Thrashers.

Implement protection measures to reduce the risk of fire which eliminates 100% of shrubs.

Prevent invasion of cheatgrass into intact shrub-steppe habitats.

Minimize further removal of sagebrush for residential, commercial, and agricultural development. Re-establish sagebrush communities where possible.

Information Needs

1. Foraging behaviour and the impact of cattle grazing on availability of insect prey and shrubs used for nesting.
2. Habitat attributes of nest sites and breeding territory.
3. The impact of tree encroachment in sagebrush-steppe habitats on habitat availability for Sage Thrasher.

Cross References

"Great Basin" Gopher Snake, Racer, "Sagebrush" Brewer's Sparrow

Requirements of the Long-billed Curlew and Grasshopper Sparrow may conflict with management prescriptions for Sage Thrasher. The Long-billed Curlew requires more open grassland, the Grasshopper Sparrow requires grassland with few or no shrubs.

References Cited

Bent, A.C. 1948. Life histories of North American nuthatches, wrens, thrashers and their allies. U.S. Natl. Mus. Bull. 195.

Blood, D.A. 1995. Wildlife in British Columbia at risk: Sage Thrasher. B.C. Min. Environ., Lands and Parks, Wildl. Br., Victoria, B.C.

Bradford, D.F., S.E. Franson, A.C. Neale, D.T. Heggem, G.R. Miller, and G.E. Canterbury. 1998. Bird species assemblages as indicators of biological integrity in Great Basin rangeland. Environ. Monit. Assessment 49:1–22.

Braun, C.E., M.F. Baker, R.L. Eng, J.S. Gashwiller, and M.H. Schroeder. 1976. Conservation Committee Report on effects of alteration of sagebrush communities on the associated avifauna. Wilson Bull. 88(1):165–171.

B.C. Ministry of Environment, Lands and Parks (MELP). 1998. Habitat atlas for wildlife at risk: South Okanagan & Lower Similkameen. Penticton, B.C.

Campbell, R.W., N.K. Dawe, I. McTaggart-Cowan, J.M. Cooper, G.W. Kaiser, M.C.E. McNall, and G.E.J. Smith. 1997. The birds of British Columbia. Vol. III: Passerines. Flycatchers through vireos. B.C. Min. Environ., Lands and Parks, Victoria, B.C., and Can. Wildl. Serv., Delta, B.C.

Cannings, R.A., R.J. Cannings, and S.G. Cannings. 1987. Birds of the Okanagan Valley, British Columbia. Royal B.C. Mus., Victoria, B.C.

Cannings, R.J. 1995. Status of the Sage Thrasher in British Columbia. B.C. Min. Environ., Lands and Parks, Victoria, B.C. Wildl. Bull. B-79.

_____. 1998. The birds of British Columbia: a taxonomic catalogue. B.C. Min. Environ., Lands and Parks, Wildl. Br. and Resour. Inventory Br., Victoria, B.C. Wildl. Bull. B-86. 243 p.

_____. 2000. Update COSEWIC status report on Sage Thrasher (*Oreoscoptes montanus*). Committee on the Status of Endangered Wildlife in Canada, Ottawa, Ont.

Castrale, J.S. 1982. Effects of two sagebrush control methods on nongame birds. J. Wildl. Manage. 46:945–952.

Committee on the Status of Endangered Wildlife in Canada (COSEWIC). 2002. Canadian Species at Risk. www.speciesatrisk.gc.ca

Darcus, S.J. 1932. The present status of the Sage Thrasher in British Columbia. Murrelet 13:22.

Dobkin, D.S. 1992. Neotropical migrant landbirds in the Northern Rockies and the Great Plains. U.S. Dep. Agric. For. Serv., Missoula, Mont. Northern Reg. Publ. R1-93-34. 144 p.

Dobler, F.C., J. Eby, S. Richardson, and M. Vander Haegen. 1996. Shrub-steppe research project: extent, ownership, and wildlife/vegetation relationships. Wash. Dep. Fish Wildl., Wildl. Manage. Program, Olympia, Wash.

Ehrlich, P.R., D.S. Dobkin, and D. Wheye. 1988. The birder's handbook: a field guide to the natural history of North American birds. Simon & Schuster Inc., Toronto, Ont.

Fraser, D.F., W.L. Harper, S.G. Cannings, and J.M. Cooper. 1999. Rare birds of British Columbia. B.C. Min. Environ., Lands and Parks, Wildl. Br. and Resour. Inventory Br., Victoria, B.C. 244 p.

Friedmann, H. and L.F. Kiff. 1985. The parasitic cowbirds and their hosts. Proc. West. Found. Vertebr. Zool. 2:226–303.

George, L.T., L.C. McEwen, and B.E. Petersen. 1995. Effects of grasshopper control programs on rangeland breeding bird populations. J. Range Manage. 48:336–342.

Godfrey, W.E. 1986. The birds of Canada. Natl. Mus. Nat. Sci., Ottawa, Ont. 595 p.

Gooding, J.W. 1970. Breeding biology of the Sage Thrasher. M.S. thesis. Cent. Wash. State Coll., Ellensburg, Wash.

Howe, F.P., R.L. Knight, L.C. McEwen, and T.L. George. 1996. Direct and indirect effects of insecticide applications on growth and survival of nestling passerines. Ecol. Appl. 6(4):1314–1324.

Howell, S.N.G. and S. Webb. 1995. A guide to the birds of Mexico and northern Central America. Oxford Univ. Press, New York, N.Y.

Kantrud, H.A. and R.L. Kologiski. 1982. Effects of soil and grazing on breeding birds of uncultivated upland grasslands of the northern Great Plains. U.S. Dep. Agric. Fish Wildl. Serv., Washington, D.C. Wildl. Res. Rep. 15.

Kerley, L.L. and S.H. Anderson. 1995. Songbird responses to sagebrush removal in a high elevation sagebrush steppe ecosystem. Prairie Natur. 27:129–146.

Knick, S.T. and J.T. Rotenberry. 1995a. Habitat relationships and breeding birds on the Snake River Birds of Prey area. Idaho Bur. Land Manage. Tech. Bull. 95-5.

_____. 1995b. Landscape characteristics of fragmented shrubsteppe habitats and breeding passerine birds. Conserv. Biol. 9:1059–1071.

_____. 1997. Landscape characteristics of disturbed shrubsteppe habitats in southwestern Idaho. Landscape Ecol. 12:287–297.

_____. 2000. Ghosts of habitats past: contribution of landscape change to current habitats used by shrubland birds. Ecology 81:220–227.

McAdoo, J.K., W.S. Longland, and R.A. Evans. 1989. Nongame bird community responses to sagebrush invasion of crested wheatgrass seedlings. J. Wildl. Manage. 53(2):494–502.

Medin, D.E. 1992. Birds of a Great Basin sagebrush habitat in west-central Nevada. U.S. Dep. Agric. For. Serv., Res. Pap. INT-452.

Millikin, R.L. 1996. Update on the Sage Thrasher *Oreoscoptes montanus* in the South Okanagan. Report prepared for B.C. Min. Environ., Lands and Parks, Wildl. Br., Penticton, B.C. Unpubl.

National Geographic Society (NGS). 1999. Field guide to birds of North America. Washington, D.C.

NatureServe Explorer. 2002. An online encyclopaedia of life. Version 1.6. NatureServe. Arlington, VA. Available at http://www.natureserve.org/explorer/

Nelson, K. 1993. Investigations into habitat needs of the Sage Thrasher *Oreoscoptes montanus* in the South Okanagan. Report prepared for the Okanagan Region Wildl. Heritage Fund Soc., B.C. Min. Environ., and Can. Wildl. Serv. Unpubl.

Paige, C. and S.A. Ritter. 1999. Birds in a sagebrush sea: managing sagebrush habitats for bird communities. Partners in Flight, Western Working Group, Boise, Idaho.

Petersen, K.L. and L.B. Best. 1987. Effects of prescribed burning on nongame birds in a sagebrush community. Wildl. Soc. Bull. 15:317–329.

_____. 1991. Nest-site selection by Sage Thrashers in southeastern Idaho. Great Basin Nat. 51(3):261–266.

Preston, A. 1990. Canyon Wren, Sage Thrasher, White-headed Woodpecker, Gray Flycatcher and Grasshopper Sparrows in the South Okanagan. Field report prepared for B.C. Min. Environ., Penticton, B.C. Unpubl.

Reynolds, T.D. 1981. Nesting of the Sage Thrasher, Sage Sparrow, and Brewer's Sparrow in southeastern Idaho. Condor 83:61–64.

Reynolds, T.D. and T.D. Rich. 1978. Reproductive ecology of the Sage Thrasher (*Oreoscoptes montanus*) on the Snake River Plain in south-central Idaho. Auk 95:580–582.

Reynolds, T.D. and C.H. Trost. 1980. The responses of native vertebrate populations to crested wheatgrass planting and grazing by sheep. J. Range Manage. 33(2):122–125.

_____. 1981. Grazing, crested wheatgrass and bird populations in southeastern Idaho. Northwest Sci. 55(3):225–234.

Reynolds, T.D., T.D. Rich, and D.A. Stephens. 1999. Sage Thrasher (*Oreoscoptes montanus*). *In* The birds of North America, No. 463. A. Poole and F. Gill, eds. The Birds of North America, Inc., Philadelphia, Penn.

Rich, T. 1980. Nest placement in Sage Thrashers, Sage Sparrows, and Brewer's Sparrows. 1980. Wilson Bull. 92(3):362–368.

Rich, T.D. and S.I. Rothstein. 1985. Sage Thrashers reject cowbird eggs. Condor 87:561–562.

Rich, T.D.G. 1978. Nest placement in Sage Thrasher. Wilson Bull. 90(2):303.

Rotenberry, J.T. and J.A. Weins. 1989. Reproductive biology of shrubsteppe passerine birds: geographical and temporal variation in clutch size, brood size, and fledgling success. Condor 91:1–14.

Saab, V.A., C.E. Bock, T.D. Rich, and D.S. Dobkin. 1995. Livestock grazing effects in western North America. *In* Ecology and management of neotropical migratory birds. T.E. Mertin and D.M. Finch (editors). Oxford Univ. Press, New York, N.Y., pp. 311–353.

Sauer, J.R., J.E. Hines, I. Thomas, J. Fallon, and G. Gough. 2000. The North American Breeding Bird Survey, results and analysis 1966–1999. Version 98.1, U.S. Geol. Surv., Patuxent Wildl. Res. Cent., Laurel, Md.

Stephens, D.A. 1985. Foraging ecology of shrubsteppe birds in central Washington. M.Sc. thesis. Central Wash. Univ.

Vander Haegen, W.M., F.C. Dobler, and D.J. Pierce. 2000. Shrubsteppe bird response to habitat and landscape variables in Eastern Washington, USA. Conserv. Biol. 14(4):1145–1160.

Weber, W.C. 1980. A proposed list of rare and endangered species for British Columbia. *In* Threatened and endangered species and habitats in British Columbia and the Yukon. R. Stace-Smith, L. Johns, and P. Joslin (editors). B.C. Min. Environ., Fish Wildl. Br., Victoria, B.C., pp. 160–182.

Weins, J.A. and J.T. Rotenberry. 1981. Habitat associations and community structure of birds in shrubsteppe environments. Ecol. Monogr. 51(1):21–41.

_____. 1985. Response of breeding passerine birds to rangeland alteration in a North American shrubsteppe locality. J. Appl. Ecol. 22:655–668.

Personal Communications

Millikin, R. 2002. Can. Wildl. Serv., Delta, B.C.

SHORT-EARED OWL

Asio flammeus flammeus

Original prepared by John M. Cooper
and Suzanne M. Beauchesne

Species Information

Taxonomy

One subspecies, *Asio flammeus flammeus*, is recognized over most of this species' range including British Columbia (AOU 1957; Cannings 1998). Eight or nine other subspecies occur in disjunct populations in South America and on islands elsewhere in the world (Holt and Leasure 1993).

Description

The Short-eared Owl is a medium-sized owl with small ear tufts. At a distance it appears to be a pale buff colour, with black "wrist" patches on the wing. Its flight is moth-like, with erratic wing beats, typically carrying it low over the ground. When perched, it sits slantwise, rather than vertical, as do most other owls of its size.

Distribution

Global

Short-eared Owls breed across subarctic and temperate North America and Eurasia as well as on the grasslands of South America and some islands including Hawaii, the Galapagos, the Falkland Islands, Cuba, Puerto Rico, Borneo, and the Philippines. Some populations are resident; however, the northernmost populations are migratory. In North America, birds winter from extreme southern Canada, south to central Mexico. Eurasian birds winter in the Mediterranean region of Europe, Northern Africa, and southern Asia to Malaysia (Holt and Leasure 1993).

British Columbia

Short-eared Owls breed locally on the south mainland coast, through the Fraser River delta east to Fort Langley, in the south and central Interior north through the Thompson and Chilcotin-Cariboo basins to Prince George, and in the Peace Lowland. It is an uncommon migrant throughout the province. The Fraser River delta is the main wintering area in the province although a few birds winter on southeastern Vancouver Island and in the southern Interior (Campbell et al. 1990).

Forest regions and districts

Coast: Campbell River, Chilliwack, North Island, South Island

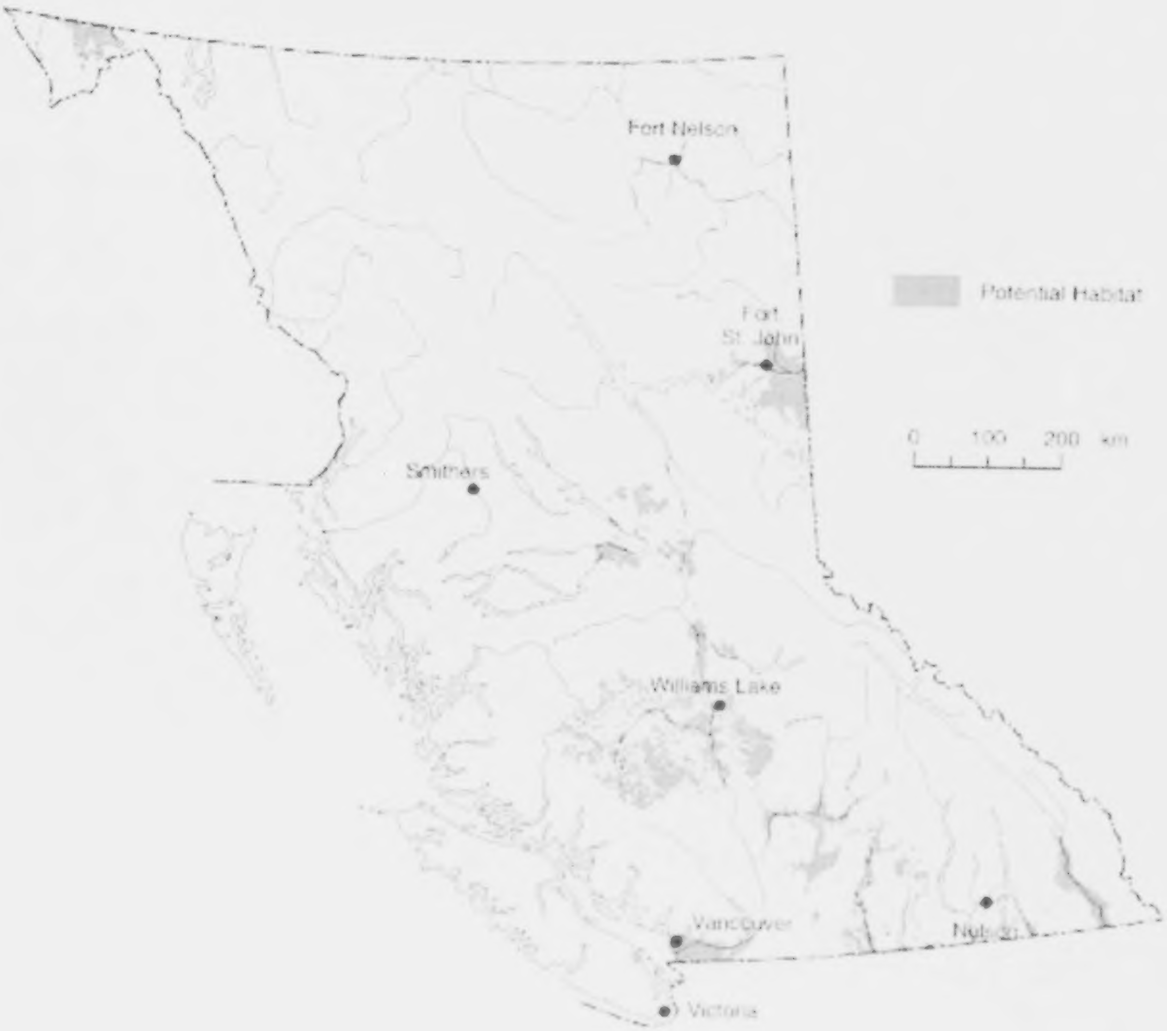
Northern Interior: Fort Nelson, Peace (Mackenzie probable), Prince George, Skeena Stikine

Southern Interior: 100 Mile House, Arrow Boundary, Central Cariboo, Chilcotin, Columbia (possible), Kamloops, Kootenay Lake, Okanagan Shuswap, Quesnel, Rocky Mountain

Ecoprovinces and ecosections

BOP: KIP, PEL
CEI: CAB, CCR, CHP, FRB, QUL
COM: NIM, WIM
GED: FRL, GEL, LIM, NAL
NBM: TAB
SBI: NEL
SIM: EKT, SCM, SFH, SPM
SOI: GUU, NIB, NOB, NOH, OKR, SHB, SOB, SOH, STU, THB, TRU
TAP: FNL, MUF, MUP

Short-eared Owl
(Asio flammeus)


Fort Nelson
Potential Habitat
Fort St. John
0 100 200 km
Smithers
Williams Lake
Vancouver
Nelson
Victoria

Note: This map represents a broad view of the distribution of potential habitat used by this species. The map is based on several ecosystem classifications (Ecoregion, Biogeoclimatic and Broad Ecosystem Inventory) as well as current knowledge of the species' habitat preferences. This species may or may not occur in all areas indicated. More detailed maps are available for this species from the Ministry of Sustainable Resource Management.

Biogeoclimatic units

BG: xh1, xh2, xh3, xw, xw1, xw2
BWBS: dk1, mw1
CDF: mm
CWH: dm, vm1, xm1, xm2
ICH: mw2, xw
IDF: dk1, dk1a, dk3, dk4, dm, mw1, mw2, un, xh1, xh1a, xh2, xh2a, xm, xw
PP: dh1, dh2, xh1, xh1a, xh2
SBS: mh, mk1
SWB: dk

Broad ecosystem units

AB, BS, CF, DF, DP, ES, GO, ME, MS, OV, PP, RR, SM, SS, UR, WG, WL, WP, WR, YB

Elevation

Near sea level to 975 m, occurrence up to 2165 m (Campbell et al. 1990)

Life History

Diet and foraging behaviour

Short-eared Owls are prey specialists, concentrating on small rodents (primarily microtines), which undergo regular population cycles (Wiebe 1991; Sullivan 1992; Holt and Leasure 1993). When microtine populations crash in one area, Short-eared Owl populations must move to find a new prey supply. Other small mammals, insects, and birds are taken in lesser quantities.

Short-eared Owls usually hunt in a low flight path over grasslands, marshes, fallow fields, and other open areas. They also hover or hunt from a perch (Wiebe 1987; Holt and Leasure 1993).

Reproduction

Monogamous pair bonds are formed in the late winter and likely last only for a single season (Holt and Leasure 1993). Nesting may begin as early as late March, although late April to early May is more common in British Columbia (Campbell et al. 1990). In British Columbia, clutch size ranges up to 13 eggs, but six or seven eggs are most common (Campbell et al. 1990). Clutch sizes are larger in times of greater prey abundance (Johnsgard 1988). The female alone incubates the eggs for 24–28 days. Incubation begins before the clutch is completed, resulting in asynchronous hatching of young. The male brings food to the incubating and brooding female. Nestlings leave the nest after about 12–16 days but are unable to fly for another 10–12 days (Holt and Leasure 1993).

Short-eared Owls begin breeding at one year of age. One brood is probably raised annually. Some researchers believe that a second brood may be raised during years of extremely abundant prey, although conclusive evidence is lacking. Restarts after nest failure have been documented (Johnsgard 1988; Holt and Leasure 1993).

Nests are placed in open areas such as fallow fields, dry marshes, or grasslands with sufficient ground cover to conceal nests. This species is unusual among owls in that it builds its own nest, rather than using the nest of another bird species (Johnsgard 1988). Nests are built on the ground, in a scrape lined with vegetation and feathers (Campbell et al. 1990; Holt 1992; Semenchuk 1992; Holt and Leasure 1993). Nests are usually on dry, raised ground, although wet areas may also be used (Holt and Leasure 1993).

Site fidelity

Nest sites are infrequently reused in subsequent years; however, it is uncertain whether this is by the same or different individuals (Bent 1938). In general, nest site fidelity is not strong, presumably because this species is nomadic. Roosts may be used year after year.

Home range

Although Short-eared Owls are territorial during the breeding season, they have been documented nesting close to one another in good habitat where prey is abundant (Johnsgard 1988). Densities of breeding pairs have been as high as 1 pair/5.5 ha (Holt and Leasure 1993). In Manitoba, mean size of five territories was 73.9 ha (Clark 1975). Territory size may decrease with increasing prey densities (Clark 1975).

In winter, this species is non-territorial, congregating where there is suitable habitat and a good prey supply. In British Columbia, roosts with up to 110 birds have been documented in the Fraser River delta (Campbell et al. 1990).

Dispersal and migration

In British Columbia, the Short-eared Owl is primarily a migratory species, with most individuals breeding in the Interior then moving southward in the fall. Populations in the northern breeding range of British Columbia begin fall migration in late October (Campbell et al. 1990). Some individuals, particularly in the Fraser River delta, are resident (Campbell et al. 1990; Sullivan 1992). It is possible that this species only migrates in search of food, and that more owls do not migrate in years when prey is abundant (Cadman 1994).

Habitat

Structural stage

Breeding

2–3 or old-growth field

Wintering

2–3a and old-growth field (multi-year crop rotation)

Important habitats and habitat features

Foraging

The Short-eared Owl requires ample, accessible prey near the nest site. Open areas with patchy vegetation provide suitable forage for small mammal prey species and opportunities for the owls to access their prey.

Nesting

Extensive open areas such as grasslands, savannahs, rangeland, or marshes with an abundant prey base, suitable nest sites, and adequate roosting sites are important breeding habitats (Cannings et al. 1987; Campbell et al. 1990). In British Columbia, most of the nests reported in Campbell et al. (1990) were found in shrubby, grassy fields adjacent to agricultural areas (e.g., pastures, fallow fields, and cultivated fields). Other sites, in order of frequency, included airport fields, marshes, open rangeland, sagebrush plains, and hayfields. In the Peace Lowlands (B.C.), uncultivated edges around wetlands are also used (M. Phinney, pers. comm.). Elsewhere, Short-eared Owls have been documented using newly cleared forests (Johnsgard 1988; Semenchuk 1992; Holt and Leasure 1993). Nests are usually situated on a raised, dry site within low, concealing vegetation (Holt and Leasure 1993).

Wintering

It is likely that the availability of suitable winter habitat with a sufficient prey base and adequate roost sites is the limiting factor for wintering populations in British Columbia (Butler and Campbell 1987; Campbell et al. 1990). Open areas such as marine foreshores, estuaries, marshes, grasslands, fallow fields, hay fields, pastures, airports, and golf courses are used by this owl (Cannings et al. 1987; Johnsgard 1988, Semenchuk 1992; Holt and Leasure 1993). In the Fraser River delta, Short-eared Owls have been reported to favour "old-field" habitat characterized by variable grass heights and shrub patches (Campbell et al. 1990; Searing and Cooper 1992; Sullivan 1992).

Prey abundance and accessibility are critical factors for wintering Short-eared Owls, both of which seem to be strongly linked with old-field habitat. In the Fraser River Valley, Townsend's Vole (*Microtus townsendii*) is the most abundant microtine and their highest densities are in old-field habitat. Small mammals also tend to be more accessible to owls in old-field habitat rather than in the uniform vegetation of cultivated fields (Cadman 1994).

Roosting

Winter roost sites must be close to hunting areas, provide protection from the weather and concealment from predators and mobbing birds, and be relatively free from human disturbance. This owl typically roosts on the ground within tall grass or shrubs, or in hedgerows (Holt and Leasure 1993). On Sea Island (British Columbia), roosts often occur in patches of Scotch broom (*Cytisus scoparius*). They will also roost in trees when snow depths exceed 5 cm (Johnsgard 1988).

Migration

Habitat requirements are probably similar to breeding season, although smaller open habitats may be used (Holt and Leasure 1993).

Conservation and Management

Status

The Short-eared Owl is on the provincial *Blue List* in British Columbia. It is considered a species of *Special Concern* in Canada (COSEWIC 2002). (See Summary of ABI status in BC and adjacent jurisdictions at bottom of page.)

Trends

Population trends

Population size and trends are difficult to assess because this owl is cyclic and nomadic, an unknown portion of the population nests in remote, unsurveyed regions, and even within easily accessible, known owl habitat, there has been a lack of consistent standardized census effort (Holt and Leasure 1993, Cadman 1994). Although these owls are occasionally active during the day, they are easily overlooked when roosting because they roost in heavy cover on the ground, and are usually well camouflaged. Estimating population size is further complicated by migration patterns because wintering, migrating and resident bird populations overlap (Cannings et al. 1987). During the breeding season, females are reluctant to flush off nests, making nests difficult to locate and breeding status difficult to determine (Holt and Leasure 1993).

At this time there is insufficient data to assess the overall population trend in British Columbia. However, Munro and Cowan (1947) suggested an apparent province-wide decline over the previous 15–20 years. In the Fraser River delta, evidence suggests that the local population has been in decline for the last few decades (Campbell et al. 1990). In addition, Christmas Bird Count data from the Lower Mainland show a steady reduction in peak number of Short-eared Owls from 1984 to 1990 (Campbell et al. 1990). In the 1960s, several hundred Short-eared Owls were banded on Sea Island (Campbell et al. 1990), but it is unlikely that the reduced amount of habitat on Sea Island today could support such numbers now.

Habitat trends

This species relies on winter habitat that has been significantly reduced and is further threatened (Tate 1986; Fraser et al. 1999). Habitat at lower elevations is undoubtedly less abundant than in the past. In the Southern Interior Mountains Ecoprovince, most low elevation grassland has been converted to agricultural lands and marshes have been drained. In the Central Interior Ecoprovince, and likely elsewhere (e.g., East Kootenay Trench ecosection), potential breeding and foraging habitat is being lost as grasslands are reduced by forest encroachment due to fire suppression (Hooper and Pitt 1995).

On the coast, estuarine marshes have been eliminated by industrial development and fallow fields have been converted to housing, industry or more intensive agricultural practices.

Threats

Population threats

As a ground nesting species, hazards to nests and nestlings include fire, flooding of marsh or coastal habitat, farm machinery, and predators (Campbell et al. 1990; Cadman 1994). Mortality in adults has

Summary of ABI status in BC and adjacent jurisdictions (NatureServe Explorer 2002)

BC	AK	CA	ID	MT	OR	WA	Canada	Global
S3B, S2N	S3N, S5B	S3	S5	S4	S4?	S4B, S4N	N4N, N5B	G5

also been attributed to shooting; collisions with cars, aircraft, and other machinery; and entanglement with barbed wire and hip chain (Holt and Leasure 1993; Cadman 1994).

Elsewhere in North America, Short-eared Owls have been extirpated from areas that still contain apparently suitable habitat. Holt and Leasure (1993) speculate that mammalian predation of eggs and nestlings could be the cause. An increase in populations of feral cats and dogs or coyotes, in combination with urbanization, likely seriously impacts this species reproductive success. These factors may be influencing local breeding populations near Boundary Bay and on Sea Island as both areas are popular with dog owners, and coyotes are now established at both locations.

Habitat threats

In British Columbia, the primary threat to this species is loss or degradation of old-field winter habitat (Butler and Campbell 1987; Campbell et al. 1990). The Fraser River delta supports the largest winter population of Short-eared Owls in the province. However, this area has been, and continues to be, modified through urbanization and increasingly intensive agricultural practices (Campbell et al. 1990). Habitat loss leads directly to a reduction in food availability causing an increase in intra- and interspecific competition (e.g., with Northern Harriers). Ongoing loss and fragmentation of habitat make new prey supplies harder to find (Cadman 1994).

Although the Short-eared Owl's breeding range in British Columbia is more widespread than its winter range, loss of nesting habitat can have an impact on local populations. Nesting habitat is especially subject to pressure from urbanization and modern agricultural practices in the Fraser and Okanagan valleys (Campbell et al. 1990). In more remote areas, nesting habitat may be degraded from overgrazing by livestock, or nests may be destroyed by mowing of meadows for hay.

Legal Protection and Habitat Conservation

The Short-eared Owl, its nests, and its eggs are protected from direct persecution in British Columbia under the provincial *Wildlife Act*.

Breeding habitat in British Columbia is associated with agricultural areas in the lower Fraser River Valley, Okanagan Valley, Thompson, and Peace lowlands. Undoubtedly, these owls also breed locally in more remote areas as well. Although a small area of wintering and breeding habitat in the lower Fraser River Valley is protected in the Alaksen National Wildlife Area, Boundary Bay Reserves, and Centennial Park (all in Delta), most of the wintering habitat in the lower Fraser River Valley, Okanagan Valley and Thompson is on private land. Delta farmers (Delta Farmland and Wildlife Trust) have an old-field management program that they operate in co-operation with the Canadian Wildlife Service; this program may help provide suitable habitat for this species on private agricultural land. Conservation of habitat on Crown land may be partially addressed by range use guidelines.

Identified Wildlife Provisions

Wildlife habitat area

Goal

Maintain important habitat features (i.e., tall grass) at traditional winter, roosting, or nesting locations.

Feature

Although Short-eared Owls tend to be nomadic, they may traditionally use areas for breeding, roosting, or wintering. Establish WHAs at traditional communal (>8 owls) roosting sites, traditional nest, or winter areas.

Size

WHAs for traditional (used for several years) roost sites will generally be 5 ha and WHAs for traditional nest sites or wintering sites will generally be 10 ha but will depend on site-specific factors.

Design

The WHA is not intended to encompass the entire area used by the owls but rather is intended to maintain key areas used for nesting, roosting, or foraging. Where appropriate, centre WHA on the known nest or roost sites.

General wildlife measure

Goals

1. Minimize human and livestock disturbance to active winter roosts and nest sites.
2. Maintain important structural features. For example, maintain a range of mid-height to tall grasses with some low shrub cover for nesting.

Measures

Access

- Do not construct roads.

Pesticides

- Do not use pesticides.

Range

- Plan livestock grazing to maintain the desired structure of plant community (i.e., tall grass), desired stubble height and browse utilization. Establish a key area to monitor structure, height, and utilization. If damage from livestock is found to be degrading the vegetative structure, fencing may be required. Consult MWLAP for fencing arrangements.
- Maintain grass structure (i.e., 50 cm or depending on the site's potential).
- Delay burning or mowing until after the breeding season (1 August).

Additional Management Considerations

Where possible, control forest encroachment into natural grassland habitat with controlled prescribed burning or other methods. Use prescribed burning in forest clearings where Short-eared Owls are nesting. Burning should occur outside of the breeding season.

In agricultural areas:

- Increase percentage of fields left fallow within winter range.
- Leave patches of shrubs and hedgerows between fields.
- Minimize disturbance by people and dogs during critical times (i.e., April through May; December through February).
- Enhance habitat for voles and other microtines, wherever possible.
- Consider fencing high use areas or known nesting areas to protect from management activities such as haying.

Old-field habitat is usually on private land. Due to the importance of old-field winter habitat for this species, landowners should be encouraged to retain or rotate fields in such a way as to maintain as much of this habitat as possible. Fields known to be used by Short-eared Owls should be managed to minimize negative impacts of disturbance by humans, vehicular traffic, and domestic animals.

Grassland, marshes, rangeland, and estuaries suitable for Short-eared Owl winter or nesting habitat should have appropriate vegetation characteristics retained and should be protected from undue disturbance by human activities.

In grassland areas, meadows should not be burned or mowed until >1 August to protect eggs and unfledged young.

Maintain a mosaic of grassland and old field habitat in suitable condition to ensure a continued supply of nesting and wintering habitat.

Information Needs

1. Status of breeding and wintering localities.
2. Impacts of human recreational use of nesting areas on reproductive success.
3. Suitability of clearcuts for foraging and nesting habitat.

Cross References

Sandhill Crane

References Cited

American Ornithologists' Union (AOU). 1957. Check-list of North American birds. 5th ed. Baltimore, Md. 691 p.

Bent, A.C. 1938. Life histories of North American birds of prey. Part 2. U.S. Natl. Mus. Bull. 170:1–482.

Butler, R.W. and R.W. Campbell. 1987. The birds of the Fraser River delta: populations, ecology and international significance. Can. Wildl. Serv., Delta, B.C. Occas. Pap. No. 65. 73 p.

Cadman, M.D. 1994. Status report on the Short-eared Owl, *Asio flammeus*, in Canada. Committee on the Status of Endangered Wildlife in Canada, Ottawa, Ont. 53 p.

Campbell, R.W., N.K. Dawe, I. McTaggart-Cowan, J.M. Cooper, G.W. Kaiser, and M.C.E. McNall. 1990. The birds of British Columbia. Vol. II: Nonpasserines. Diurnal birds of prey through woodpeckers. Royal B.C. Mus., Victoria, B.C., and Can. Wildl. Serv., Delta, B.C. 636 p.

Cannings, R.A., R.J. Cannings, and S.G. Cannings. 1987. Birds of the Okanagan Valley, British Columbia. Royal B.C. Mus., Victoria, B.C. 420 p.

Cannings, R.J. 1998. The birds of British Columbia–a taxonomic catalogue. B.C. Min. Environ., Lands and Parks, Wildl. Br., Victoria, B.C. Wildl. Bull. No. B-86. 252 p.

Clark, R.J. 1975. A field study of the Short-eared Owl, *Asio flammeus* (Pontoppidan), in North America. Wildl. Monogr. 47:1–67

Committee on the Status of Endangered Wildlife in Canada (COSEWIC). 2002. Canadian Species at Risk. www.speciesatrisk.gc.ca

Fraser, D.F., W.L. Harper, S.G. Cannings, and J.M. Cooper. 1999. Rare birds of British Columbia. B.C. Min. Environ., Lands and Parks, Wildl. Br. and Resour. Inventory Br., Victoria, B.C. 244 p.

Holt, D.W. 1992. Notes on Short-eared Owl (*Asio flammeus*) nest sites, reproduction and territory sizes in coastal Massachusetts. Can. Field-Nat. 106:352–356.

Holt, D.W. and S.M. Leasure. 1993. Short-eared Owl (Asio flammeus). In The birds of North America, No. 62. A. Poole and F. Gill (editors). Acad. Natl. Sci., Philadelphia, Penn., and Am. Ornith. Union, Washington, D.C. 22 p.

Hooper, T.D. and M.D. Pitt. 1995. Problem analysis for Chilcotin-Cariboo grassland biodiversity. B.C. Min. Environ., Lands and Parks, Wildl. Br., Victoria, B.C. Wildl. Bull. B-82.

Johnsgard, P.J. 1988. North American Owls: Biology and natural history. Smithsonian Inst. Press, Washington, D.C.

Munro, J.A. and I. McTaggart-Cowan. 1947. A review of the bird fauna of British Columbia. B.C. Prov. Mus. Spec. Publ. 2, Victoria, B.C. 285 p.

NatureServe Explorer. 2002. An online encyclopaedia of life. Version 1.6. NatureServe. Arlington, VA. Available at http://www.natureserve.org/explorer/

Searing, G.F. and J.M. Cooper. 1992. Raptor/heron management plan for airport reserve lands on Sea Island, Richmond, British Columbia. Report by LGL Limited, Sidney, B.C. Unpubl.

Semenchuck, G.P. 1992. The atlas of breeding birds of Alberta. Fed. Alberta Naturalists, Edmonton, Alta. 391 p.

Sullivan, T.M. 1992. Population, distribution and habitat requirements of birds of prey. *In* Abundance, distribution and conservation of birds in the vicinity of Boundary Bay, British Columbia. R.W. Butler (editor). Can. Wildl. Serv., Delta, B.C. Tech. Rep., 86–108.

Tate, J. 1986. The Blue List for 1986. Am. Birds 40:227–226.

Wiebe, K.L. 1987. Behaviour, habitat, population trends, and management of Short-eared Owls in southwestern British Columbia. Report for Simon Fraser Univ., Burnaby, B.C. Unpubl.

_____. 1991. Food habits of short-eared owls in southwestern British Columbia. J. Raptor Res. 25(4):143–145.

Personal Communications

Phinney, M. 2000. Louisiana-Pacific Canada Ltd., Dawson Creek, B.C.

SPOTTED OWL

Strix occidentalis

Original by Ian Blackburn and Stephen Godwin

Species Information

Taxonomy

Three subspecies are recognized: Mexican Spotted Owl (*Strix occidentalis lucida*), California Spotted Owl (*S. occidentalis occidentalis*), and Northern Spotted Owl (*S. occidentalis caurina*) (Dawson et al. 1986; Wilcove 1987). Starch-gel electrophoresis was unable to detect variation between *S. occidentalis occidentalis* and *S. occidentalis caurina*; however, *S. occidentalis lucida* did show variation, suggesting the possibility of two distinct species (Barrowclough and Gutierrez 1990). In addition, two separate evolutionary histories have been demonstrated by the major allelic frequency difference between *occidentalis/caurina* and *lucida* (Barrowclough and Gutierrez 1990).

Description

The Spotted Owl is considered a medium-sized owl with an average height of about 45 cm, and average wingspan of about 90 cm. The plumage consists largely of dark brown body feathers with a regular pattern of round to elliptical white spots, white horizontal bars on the chest and tail, large dark brown eyes surrounded by tawny facial disk, and no ear tuffs. Male and female Spotted Owls have similar plumage. Females may be distinguished by their comparatively larger body size (females: $n = 65$, mean = 663 g, SD = 42.8 g; males: $n = 68$, mean = 579 g, SD = 34.9 g; Blakesley et al. 1990), and higher pitch of their vocalization (Forsman et al. 1984).

Distribution

Global

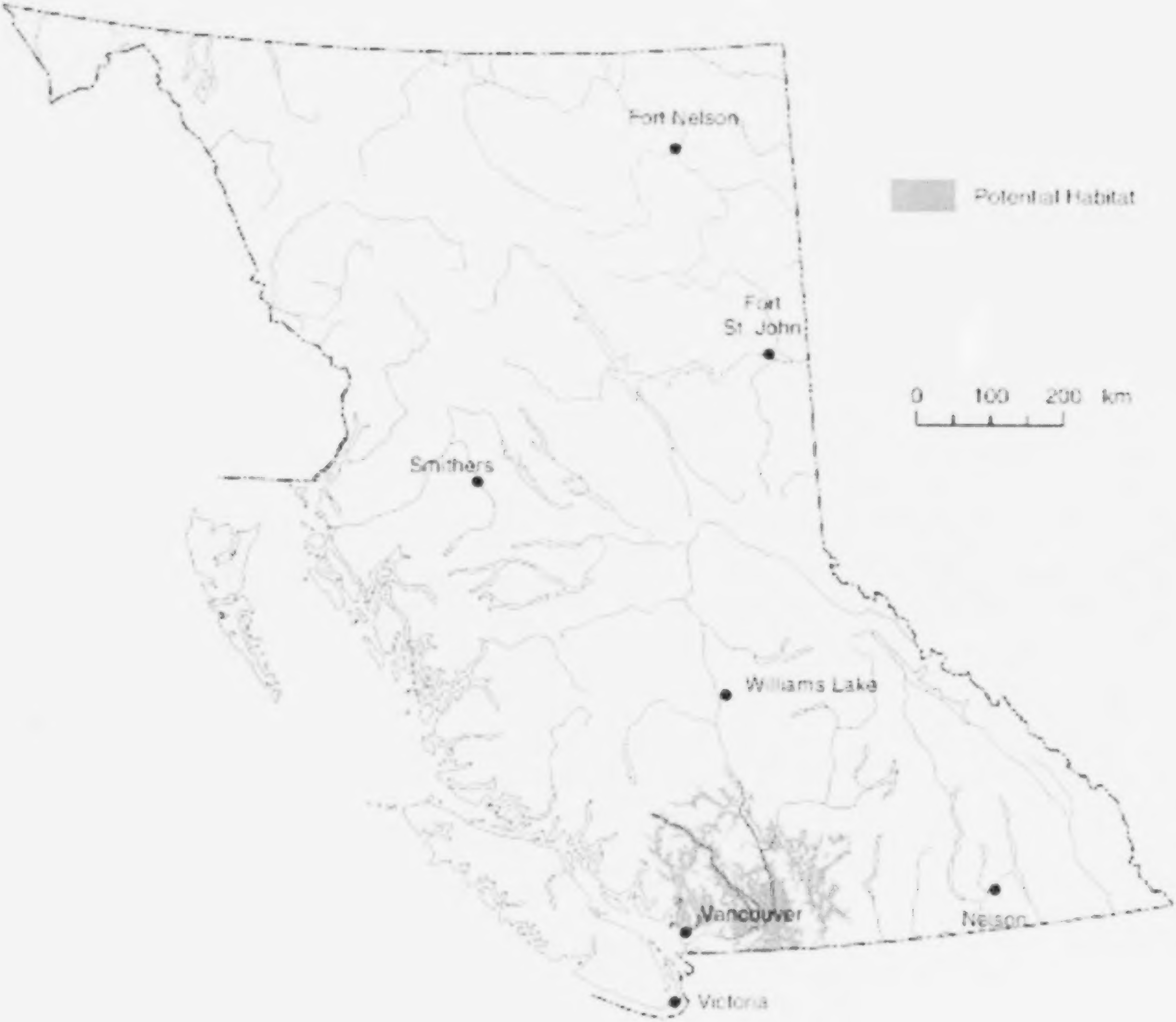
The Spotted Owl occurs from southern British Columbia south to central Mexico. The Mexican Spotted Owl ranges from southern Utah and central Colorado, south through the mountainous regions of Arizona and New Mexico; Guadelupe Mountains of western Texas; mountains of northern and Central Mexico south to Michoacan and Guanajuato. The California Spotted Owl ranges from southeastern Shasta County, south through the Sierra Nevada to Kern County, through the Coast Ranges from Monterey County to San Diego County to northern Baja California (Sierra San Pedro Martir). The Northern Spotted Owl ranges from southwestern mainland British Columbia, western Washington, western Oregon, to northwestern California.

British Columbia

Based on historic (pre-1985, n=28) and recent ($n = 65$) records, the current known range of the Spotted Owl in British Columbia extends from the international border north about 200 km to Carpenter Lake, and from Howe Sound and Pemberton east about 160 km to the slopes of the Cascade Mountain range (MWLAP 2003). There are unconfirmed historic records occurring as far northwest as Bute Inlet in the Sunshine Coast Forest District (Laing 1942). Although the Spotted Owl occurred historically in the lowlands of the lower Fraser River Valley, the species is thought to be extirpated from this area as a result of the extensive loss of old forests due to urbanization, agriculture, and forestry. Despite relatively recent historic records, survey efforts conducted between 1992 and 1997 in the Squamish and Whistler corridor were

Spotted Owl

(Strix occidentalis)


Fort Nelson
Potential Habitat
Fort St. John
0 100 200 km
Smithers
Williams Lake
Vancouver
Nelson
Victoria

Note: This map represents a broad view of the distribution of potential habitat used by this species. The map is based on several classifications (Forest Cover Data and Biogeoclimatic) as well as current knowledge of the species' habitat preferences. This species may or may not occur in all areas indicated. More detailed maps are available for this species from the Ministry of Sustainable Resource Management.

unsuccessful at detecting Spotted Owls, suggesting that the species may have become locally extirpated in this area. The full extent of the range of Spotted Owls in British Columbia is still unknown. Inventories are still required to assess the western, northern, and eastern extent of the species range.

Forest region and districts

Coast: Chilliwack, Squamish
Southern Interior: Cascades

Ecoprovinces and ecosections

COM: EPR, NWC, SPR
GED: FRL
SOI: LPR, HOR

Biogeoclimatic units

CWH: dm, ds1, mm1, ms1, ms2, vm1, vm2
ESSF: mw
IDF: dk2, ww
MH: mm1

Broad ecosystem units

AU, AV, CD, CH, CW, DF, DL, EW, FR, IH, MF, RD

Elevation

~0–1370 m

Life History

Diet and foraging behaviour

Spotted Owls are nocturnal and considered a sit and wait predator that moves from perch to perch waiting to detect prey. Spotted Owls primarily prey on small mammals, although they have been known to predate on a broad array of taxa including birds, amphibians and insects (Forsman et al. 1984). The composition of their diet varies among regions and forest types. In general, their diet includes flying squirrels, deer mice, tree voles, woodrats, red-backed voles, and hares. Pellet analysis of Spotted Owls in British Columbia revealed the largest contribution (41.2%) to the owl's diet is Northern Flying Squirrels (*Glaucomys sabrinus*) and bushy-tailed woodrats (*Neotoma cinerea*) (27.8%; Horoupian et al. 2000), which is consistent with other studies throughout the species range (Forsman et al. 1984; Forsman et al. 2001). Flying squirrels are also nocturnal, and tend to be more abundant in old forests than in young forests; however, their density in old forests is low (Carey et al. 1992). In British Columbia, Ransome (2001) found the density of Flying Squirrels in old forest in the wet coastal ecosystem to be 1.5 ± 1.8 squirrels/ha (range 0.3–2.9) and in second-growth stands to be 1.0 ± 1.4 squirrels/ha (range 0.06–1.8). Although the densities in British Columbia were not significantly different, the results suggest densities of flying squirrels may be higher in old forests. Even a potential 0.5 squirrel/ha more in old forest than second growth could translate to significantly more squirrels within a home range and improve the owls' likelihood of survival and reproduction. Due to this low density of prey, the Spotted Owl requires large amounts of old forest for foraging (Carey et al. 1992).

Reproduction

Spotted Owls are typically monogamous, although evidence suggests a low, but frequent occurrence of separation between pairs (Forsman et al. 2002). In late winter, Spotted Owls begin roosting together near the nest 4–6 weeks prior to egg laying, with copulation generally occurring 2–3 weeks before nesting (Forsman et al. 1984). The average clutch size is two owlets ± one owlet. The incubation period is estimated to be approximately 30 days ± 2 days (Forsman et al. 1984). Females incubate and brood the juveniles while the males provide food for both females and juveniles (Forsman et al. 1984). Most juveniles leave the nest when they are 34–36 days old. Although the mean date when juveniles left the nest varied among years, Forsman et al. (2002) reported mean dates of June 8 ± 0.53 days in Oregon ($n = 320$ owls, range May 15 to July 1) and June 18 ± 1.67 days in Washington ($n = 77$, range May 13 to July 15). Similar to Washington, juveniles at two locations in British Columbia were observed off the nest between June 15 and June 20 (Hobbs 2002); however, juveniles have been observed off the nest in British Columbia as early as on June 7 (D. Dunbar, pers. comm.). The results support Forsman et al. (1984) that nesting typically occurs earlier in southern portions of the species range in

North America. In Washington and Oregon, renesting after a nest failure was rare, only occurring 1.4% of the time after an initial failure (Forsman et al. 1995).

In Washington and Oregon, Forsman et al. (2002) reported that 22% of males and 44% of females were paired at 1 year of age; however, only 1.5% of 1-year-old males and 1.6% of 1-year-old females actually bred. Typically, Spotted Owls begin breeding at 3 years of age. Franklin et al. (1999) note that fecundity appears to vary over time with evidence of a bi-annual cycle where by more young fledged in even years than odd years (even/odd effect). The cause of this cyclic pattern is unknown, but may be linked to weather or prey populations (Franklin et al. 1999).

Site fidelity

Spotted Owls typically have strong fidelity to breeding sites and tend to occupy the same geographic area for long periods of time (Forsman et al. 1984). Forsman et al. (2002) observed a minimum 6% of non-juvenile owls changed territories annually. The frequency of these non-juvenile movements was higher for female owls, younger owls, and owls without a mate or who had lost their mate through death or separation in the previous year. In the Olympic Mountain range in Washington, owl pairs changed nests in 75% of sequential nesting attempts; 40% returned to a nest used previously (Forsman and Giese 1997). The median distance between these alternate nests was 0.52 km (range 0.03–3.35 km; $n = 92$).

Home range

Home range sizes vary by geographic location, with a general increasing trend from southern to northern portions of the species range (Thomas et al. 1990). For example, home range sizes have been reported as small as 549 ha for a single owl in Oregon (Forsman et al. 1984) and as large as 11 047 ha for a pair of owls in Washington (Hanson et al. 1993). The size of an owl's home range depends on many factors including food availability; interspecific and intraspecific competition; presence of predators; and the quantity, quality, and dispersion of suitable habitats (USDI 1992). For example, decreasing the density of suitable habitat or prey populations within the landscape may result in an increase in home range size as owls expand their foraging area to find sufficient amounts of habitat with prey.

In Washington, the median annual home range for a pair of owls for the west side and east side of the Cascade Mountain range was estimated at about 3321 ha (range 1302–7258 ha) and 2675 ha (range 1490–6305 ha), respectively, with a total suitable habitat composition of 67% and 71%, respectively (Hanson et al. 1993). In British Columbia, annual home range estimates for 3 pairs of owls in the drier ecosystem ranged from 1732 to 4644 ha, with suitable habitat compositions ranging from 60 to 66% (A. Hilton, pers. comm.). However, these home ranges for British Columbia are likely underestimated due to the small sample size and limited seasonal tracking duration. Annual home range sizes for British Columbia are likely comparable to those in Washington, if not slightly larger.

Forsman et al. (1984) observed an average 68% home range overlap between paired individuals. Despite this overlap, paired individuals used the same locations for foraging only 4–10% of the time, suggesting little competition for food between paired individuals. In contrast, adjacent, non-paired individuals overlap their home ranges by about 12% where both owls tend to spend relatively small portions of their time in the periphery of their home range (Forsman et al. 1984).

Movements and dispersal

Juveniles are obligate dispersers and typically leave their natal area by September 19 (95% CI, September 17 to 21) in Oregon and September 30 (95% CI, September 25 to October 4) in Washington (Forsman et al. 2002). In British Columbia, the latest date that juveniles owls were observed with their parents was September 28 (2 records; MWLAP 2003), suggesting that the initial date of dispersal is likely similar to Washington. The direction of dispersal appears random; however, it may be influenced by barriers such as high elevation terrain, large bodies of water, and large open areas of unsuitable habitat (Thomas et al. 1990; Miller et al. 1997; Forsman et al. 2002). Distances between the natal area and where the owls eventually settled ranged from 0.6 to 111.2 km apart; however, the distribution of distances were skewed towards shorter distances (Forsman et al. 2002). Female juveniles typically disperse farther than males, with 50% of female and male juveniles settling within 22.9–24.5 km and 13.5–14.6 km from their natal areas, respectively (Forsman et al. 2002).

Habitat

Structural stage

6: mature forest
7: old forest

Important habitats and habitat features

Nesting

Spotted Owls do not create their owl nest structures, but use a variety of pre-formed structures that includes cavities in the side and top of trees, and platforms constructed by other birds or by natural accumulations of debris (Forsman et al. 1984; Dawson et al. 1986; Buchanan et al. 1993; Forsman and Giese 1997). Nest structures are about 50 cm in diameter, and typically do not differ in size by nest type or geographic region (Forsman and Giese 1997). However, tree species and size of nest trees (dbh) are geographically variable and selection is thought to be based largely on the availability of suitable cavities and platforms. Regardless of geographic region, cavity nests were in trees with greater diameters than platform nests (Table 1).

In wetter ecosystems, Spotted Owls primarily nest in cavities in large diameter trees typically found in old forest stands or younger stands with residual large diameter old trees (Thomas et al. 1990; Forsman and Giese 1997). In the Olympic Mountain range, nest trees averaged 136.6 cm dbh and were predominantly western hemlock (*Tsuga heterophylla*), western redcedar (*Thuja plicata*), and Douglas-fir (*Pseudotsuga menziesii*) ranging from 114 to 1189 m in elevation. In drier ecosystems, Spotted Owls nest in a wide range of forest stand ages ($n = 62$, median age = 147 yr, range 66–700 yr; Buchanan et al. 1993) and forest structures. On the eastern slopes of the Cascade Mountain range in Washington, nest trees averaged 66.5 cm dbh and were found almost exclusively in Douglas-fir trees ranging from 381 to 1463 m in elevation (Buchanan et al. 1993, 1995). In contrast to wetter ecosystems, 84% ($n = 85$) of Spotted Owl nests were on platforms in trees created by abandoned Northern Goshawk (*Accipiter gentilis*) nests ($n = 47$) or mistletoe brooms ($n = 21$), with only 16% of nests found in cavities or tops of trees (Buchanan et al. 1993). In British Columbia, nests have been similarly found in cavities of large diameter living western redcedar, western hemlock, and Douglas-fir trees, in tops of large diameter dead Douglas-fir snags, and in abandoned Northern Goshawk nests.

Foraging

Three habitat types have been defined in Washington based on their use by Spotted Owls for nesting, roosting and foraging (Hanson et al. 1993). Superior habitats are preferred by Spotted Owls as these habitats are used by the owl in greater proportion than the availability of this habitat type in the landscape. Moderate habitats are used by Spotted Owls in equal proportion to the availability of this habitat type in the landscape. Marginal habitats are used less than this habitat type's availability in the landscape, and are considered unsuitable for sustained use by Spotted Owls. Table 2 defines the stand characteristics for superior and moderate habitats for the wetter and drier ecosystems.

Spotted owls are a sit and wait predator that usually roost within or adjacent to forest stands used for foraging. The structural diversity found in superior habitat type provides for numerous roosting and foraging perches at various heights in the canopy and understorey. The openness of these stands allow for greater maneuverability within the canopy layers and greater access to prey. These open stands tend to possess higher quantities of understorey shrubs and herbs that support higher densities of prey. The characteristics of superior habitat is predominantly found within old forest (forests >140 yr); however, some younger forests, particularly in drier ecosystems, may also possess these characteristics.

Table 1. Comparison of nest tree diameter at breast height (dbh), tree height, and nest diameter among three geographic regions in Washington and Oregon

	Cavity nests			Platform nests		
	n	mean	SD/SE	*n*	mean	SD/SE
Washington Olympic Mountains – (Forsman and Giese 1997)						
dbh (cm)	99	141.8	6.15 SE	11	88.7	15.74 SE
Tree height (m)	95	40.7	1.36 SE	11	39.8	3.99 SE
Nest diameter (cm)	76	45.3	1.15 SE	10	48.0	4.59 SE
Washington Eastern Slopes of Cascade Mountains – (Buchanan et al. 1993)						
dbh (cm)	14	94.7	23.1 SD	71	59.4	21.6 SD
Tree height (m)		Not reported			Not reported	
Nest diameter (cm)		Not reported			Not reported	
Oregon – (Forsman et al. 1984)						
dbh (cm)	28	135.0	6.03 SE	16	106.0	11.93 SE
Tree height (m)	28	38.1	2.37 SE	16	42.0	3.42 SE
Nest diameter (cm)	20	50.0	0.93 SE	8	62.0	1.32 SE

Table 2. Suitable Spotted Owl habitat definitions for British Columbia (SOMIT 1997)

Superior habitat (nest, roost, forage and dispersal)	**Moderate habitat** (roost, forage, and dispersal)
Wetter ecosystems: maritime CWH and MH biogeoclimatic zones (CWHdm, CWHvm1, CWHvm2, MHmm1)	
• ≥3 canopy layers, multi-species canopy dominated by large (>75 cm dbh) overstorey trees (typically 37–185 stems/ha) • moderate to high (60–80%) canopy closure • ≥5 large (>50 cm dbh) trees/ha with various deformities (e.g., large cavities, broken tops, dwarf mistletoe infections) • ≥5 large (>75 cm dbh) snags/ha. • accumulations (≥268 m^3/ha) of fallen trees and other CWD on ground	• ≥2 canopy layers, multi-species canopy dominated by large (>50 cm dbh) overstorey trees (typically 247–457 stems/ha, although densities as low as 86 stems/ha are possible where large diameter trees are present) • moderate to high (60–80%) canopy closure • ≥5 large trees/ha (>50 cm dbh) with various deformities (e.g., large cavities, broken tops, dwarf mistletoe infections) • ≥5 large (>50 cm dbh) snags/ha • accumulations (≥100 m^3/ha) of fallen trees and other CWD on ground
Drier ecosystems: sub-maritime CWH and MH, IDF, and ESSF biogeoclimatic zones (CWHds1, CWHms1, CWHms2, MHmm2, ESSFmw, IDFww)	
• ≥3 canopy layers, multi-species canopy dominated by large (>50 cm dbh) overstorey trees (typically 173–247 stems/ha, although densities as low as 86 stems/ha are possible where large diameter trees are present) • moderate to high (60–85%) canopy closure • ≥5 large trees/ha (>30 cm dbh) with various deformities (e.g., large cavities, broken tops, dwarf mistletoe infections) • ≥7 large (>50 cm dbh) snags/ha. • accumulations (≥268 m^3/ha) of fallen trees and other CWD on ground	• ≥2 canopy layers, multi-species canopy dominated by large (>30 cm dbh) overstorey trees (typically greater than 247 stems/ha) • stands must contain 20% Fd and/or Hw in the overstorey • >50% canopy closure. • ≥5 large trees/ha (>30 cm dbh) with various deformities (e.g., large cavities, broken tops, dwarf mistletoe infections) • ≥5 large (>30 cm dbh) snags/ha • accumulations (≥100 m^3/ha) of fallen trees and other CWD on ground

Conservation and Management

Status

The Spotted Owl is on the provincial *Red List* in British Columbia. It is considered *Endangered* in Canada (COSEWIC 2002). The "Northern" Spotted Owl is federally designated as Threatened throughout its entire range in the United States under the U.S. *Endangered Species Act.*

Summary of ABI status in BC and adjacent jurisdictions (NatureServe Explorer 2002)

BC	CA	OR	WA	Canada	Global
S1	S2	S3	S3	N1	G3T3

Trends

Population trends

Blackburn et al. (2002) estimated the historic (pre-European settlement) Spotted Owl population size in British Columbia as about 500 pairs of owls. Between 1992 and 2001, the Spotted Owl population declined by about 49% at an average annual rate of -7.2% (± 1.7% for 90% CI; Blackburn et al. 2002). Survey results from 2002 suggest that the population declined by an additional 35% between 2001 and 2002. Combined, the Spotted Owl population has declined by about 67% since 1992 at an average rate of -10.4%/yr (Blackburn and Godwin 2003). Applying this observed decline to the fewer than 100 pairs of owls estimated in British Columbia in the early 1990s (Dunbar et al. 1991) suggests that the current Spotted Owl population in British Columbia may be fewer than 30 pairs of owls. It is reasonable to assume that the extirpation of the Spotted Owl from British Columbia is imminent if the observed annual rate of decline continues (Blackburn et al. 2002).

The observed large decline is Spotted Owl numbers is not exclusive to British Columbia. In the United States, monitoring of Spotted Owls at 15 different demographic study areas between 1985 and 1998 suggests a range-wide annual population decline of -3.9% (± 3.6% for 95% C.I.; Franklin et al. 1999).

Habitat trends

Since European settlement, timber harvesting for urbanization, agriculture, and resource extraction has occurred, with almost the entire forested area in the lower Fraser River Valley converted to non-forest uses. It is estimated that suitable habitat represents about 50% of the current capable forested area in the two forest districts (Blackburn et al. 2002). Some of these habitats are currently unusable by Spotted Owl due to their small patch size, isolation from other habitat patches, or distribution in landscapes with suitable habitat densities too low to support the species. Over the next 25 years, the rate of habitat loss caused by timber harvest and natural disturbance is expected to exceed the recruitment of suitable habitat from young forests, resulting in further fragmentation and isolation of habitats available to the owl (Blackburn and Godwin 2003).

Threats

Due to their small population size and low densities, Spotted Owls in British Columbia are vulnerable to extirpation. Factors that threaten the species can be divided into primary and secondary factors (Blackburn and Godwin 2003). Primary factors cause long-term sustained effects that limit the carrying capacity, or total capable population size. Primary factors include habitat loss and fragmentation, competition with Barred Owls (*Strix varia*), and global warming. Secondary factors cause short-term effects in population size, but the population recovers from these factors relatively soon after the influence of the factor changes to a more favourable condition. Secondary factors include stochastic environmental and demographic events, genetic variability, predation, disease, parasites, and viruses. Although primary factors limit population size and may cause extirpation, secondary factors are likely the leading cause of extirpation of small populations.

Population threats

Since the 1960s, Barred Owls have invaded the range of the Spotted Owl. Although some niche segregation is evident (Hamer et al. 1989), Barred Owls likely exclude Spotted Owls from utilizing some mature and old forests found within core Barred Owl territories. As well, the presence of both species within the same geographic area may suppress prey populations. The combined competitive effect of habitat exclusion and prey suppression may cause Spotted Owls to increase their home range size to compensate for this loss, or cause the displacement of Spotted Owls as they leave their territory to find new territories with less competition (Kelly 2001). In addition to these competitive effects, the low occurrence of cross breeding between Spotted Owls and Barred Owls negatively impacts the reproductive success of the Spotted Owl population by effectively removing adult Spotted Owls from the pool of potential breeders.

Catastrophic environmental events such as fire, windstorms, and insect outbreaks may eliminate both habitat and Spotted Owls that they support (Thomas et al. 1990). As well, severe weather events may cause poor reproductive performance or high adult mortality, resulting in periodic gaps in the demographic profile. If the population cannot recover from these events, the population may continue to decline to extirpation as future stochastic events occur.

Isolated small populations are prone to decreased genetic variability caused by founder effects, increased incidence of inbreeding, and/or genetic drift. Isolated populations may have higher incidences of adult and juvenile mortality caused by pronounced deleterious recessive genes, reduced adaptability to environmental change, and/or higher susceptibility to disease. Furthermore, closely related individuals may not mate at all, thereby reducing the productivity and recruitment of the population. Decreasing population size and increasing isolation of individuals and populations places the Spotted Owl population in British Columbia at greater risk of extirpation caused by the loss of genetic variability.

Spotted Owls are incidental prey to several predators including Great Horned Owls (*Bubo virginianus*) and Northern Goshawks. Ravens are also predators, more likely preying on very young owls and eggs rather than adult owls. Some researchers also include Barred Owls as a possible predator, although evidence is limited (Kelly 2001). Most predation of individuals is thought to occur during juvenile dispersal, when young owls are inexperienced and searching for new habitats. Perhaps the increasing abundance of unsuitable habitats within the landscape has increased the exposure of dispersing Spotted Owls to predators as they move through these unsuitable habitats resulting in an increased rate of mortality. For predators to be the main cause of the population decline requires the rate of mortality to be higher than normal mortality rates caused by predation.

Spotted Owls are prone to disease, parasites, and viruses; however, these seldom result in sufficient mortality to cause population declines. Of recent concern is the range expansion of the West Nile Virus. The West Nile Virus is usually transmitted to birds through mosquitoes, where once established in a bird, mortality may follow. Those that survive may act as carriers to help spread the virus. Although the West Nile Virus does not occur within southwestern British Columbia, it likely is only a matter of time before it does. Its potential impact on the Spotted Owl is not known; however, there is a risk that it could cause further declines in Spotted Owl numbers in British Columbia.

Habitat threats

Habitat is threatened by timber harvesting, urbanization, and natural disturbances such as fire, wind, insects, and diseases. Habitat loss and fragmentation may increase the risk of mortality caused by predation and exposure of owls that must move through unsuitable habitats to reach other suitable habitats. Within an owl's territory, habitat loss and fragmentation may cause the resident owls to increase their home range size to compensate for this habitat loss and need to find sufficient prey. As well, habitat loss and fragmentation may reduce the reproductive success and adult survivorship as adult owls must expend more energy to find food farther away from their core area. Eventually continued habitat loss and fragmentation within a home range will surpass the minimum threshold needed to sustain owls, and the area will remain vacant from Spotted Owls until habitats are restored. As a result, the number of potential territories available in the landscape is reduced. Isolation of territories occurs as the interspatial distances between territories exceed the maximum distance needed for successful dispersal. Without successful dispersal, isolated territories and populations will eventually decline to extirpation.

Legal Protection and Habitat Conservation

The Spotted Owl, its nests, and its eggs are protected under the provincial *Wildlife Act.*

A Spotted Owl Recovery Team was formed in 1990 to develop a recovery plan for the species. At the request of the provincial government, the recovery team developed a range of management options that spans the scale from minimum to maximum protection for Spotted Owl with correspondingly minimum to maximum socio-economic consequences (Dunbar and Blackburn 1994). In 1997, the provincial Cabinet approved the Spotted Owl Management Plan (SOMP) with the goal of achieving a reasonable level of probability that owl populations will stabilize, and possibly improve, over the long term without significant short-term impacts on timber supply and forest employment. The SOMP recognizes that the Spotted Owl population will continue to decline over the next 20–30 years with a 60% chance of the population stabilizing, and possibly improving its status over the long term. Timber supply impacts of SOMP are estimated at between 3 to 5% reduction in allowable annual cut. The SOMP includes a strategic and operational guidelines component, and Resource Management Plans. The strategic component describes the strategic objectives and policies for Spotted Owl management in 21 special resource management zones (SRMZs) totalling about 363 000 ha) identified for the long-term conservation of the species. The operational guidelines component provides resource managers with further guidance for developing long-term Resource Management Plans within SRMZs, and forest practices that will create or retain forest attributes critical for Spotted Owl survival. Resource Management Plans demonstrate how, over a long-term planning horizon of one or more forest rotations, the Spotted Owl and forest management objectives and policies will be achieved in each SRMZ. Resource Management Plans identify landscape and stand level management strategies that are expected to best protect suitable habitat and to provide forestry, economic and employment opportunities.

The 21 SRMZs include 159 000 ha of protected areas (includes capable/suitable habitats within the Greater Vancouver Watershed Districts: Seymour, Capilano, and Coquitlam; protected areas: Seymour, Cypress, Garibaldi, Golden Ears, Sasquatch, Manning, Skagit, Pinecone/Burke Mountain, Birkenhead Lake, Mehatl Creek, and Liumchen) and 204 000 ha of Crown forest land. The SRMZs are spaced a maximum 20 km apart to provide a reasonable chance that owls can disperse from one SRMZ to another. Each SRMZ varies in size and contains between 2 to 13 Long-term Activity Centre (LTACs), each about 3200 ha and capable of sustaining a breeding pair of Spotted Owls in the future. The long-term stabilization, and possible improvement, of the Spotted Owl population is dependent upon maintaining, or restoring, a minimum 67% of the gross forested area as suitable habitat (i.e., forests >100 years old, taller than 19.4 m, and below 1370 m) in each LTAC. Of the 101 LTACs identified within SRMZs, only 55 LTACs currently meet the minimum 67% habitat target. Recruitment of habitat up to this minimum target in the other 45 LTACs may require up to 60 years.

The SOMP provides temporary protection for an additional eight activity centres (referred to as Matrix Activity Centres) that are found entirely or partially outside of SRMZs. These Matrix Activity Centres are to be phased out by allowing, over a 50-year period, limited clearcutting of suitable habitat at a similar rate as suitable habitat is recruited within SRMZs. However, some Matrix Activity Centres will be phased out sooner to achieve forest company timber needs to offset the impacts associated with the creation of the Mehatl Creek Protected Area (SOMIT 1997).

The SOMP does not provide protection over existing provisions of the *Forest and Range Practices Act*, to Spotted Owl activity centres found outside of SRMZs, Matrix Activity Centres, and protected areas discovered after June 1995. Since June 1995, 19 Spotted Owl activity centres have been discovered and remain unprotected. Fourteen of these occur farther north beyond the managed range of SOMP, eight of which occur in the Cascades Forest District (formerly the Lillooet Forest District).

Due to concern over the Endangered status and immediate threat of extirpation, a Spotted Owl Recovery Team was re-established in 2002 to develop a Recovery Plan including assessing the SOMPs effectiveness for stabilizing the population. Completion of the Spotted Owl Recovery Plan is expected by 2005.

Identified Wildlife Provisions

Sustainable resource management and planning recommendations

Due to the status of the Spotted Owl in British Columbia, all individual owls are critical to the recovery of the species and should be considered for protection. The following recommendations may be considered within strategic level planning processes. These recommendations are consistent with the Spotted Owl Management Plan, and its associated documents, and are recommended for the management of habitat to sustain a pair of Spotted Owls (see SOMP for more information). These management provisions may change pending the implementation of a Spotted Owl Recovery Plan or other direction from government.

- Maintain suitable Spotted Owl habitat (i.e., coniferous forest >100 years old, >19.4 m tall and <1370 m elevation).
- Maintain LTACs throughout the range of the Spotted Owl.
- Where possible aggregate LTACs into clusters of multiple breeding territories.
- Where possible the distance between LTACs and clusters of LTACs should be <20 km.
- Where the distance between LTACs is >20 km, consider establishing an additional LTAC to ensure habitat connectivity to facilitate dispersal.
- Maintain or restore suitable habitat within LTACs.
- Wherever possible and practicable, overlap LTACs with other constrained areas (i.e., protected areas, non-contributing areas) to minimize timber supply impacts.

Wildlife habitat area

Goal

Maintain areas of suitable habitat throughout the range of the Spotted Owl.

Feature

Establish WHAs at resident Spotted Owl areas consistent with current government direction. WHAs may be established to legalize existing LTACs under FRPA, to modify existing LTACs, to protect new resident Spotted Owl areas or to protect other habitat for recovery.

Size

The size of the WHA will generally be 3200 ha of forested area.

Design

The WHA should include a core area(s) (80 ha), and a management zone which includes a long-term owl habitat area (light volume removal) and a forest management area (heavy volume removal). The WHA should include an 80 ha core area around all known nesting or roosting sites. The WHA should also include a minimum of 67% suitable habitat (i.e., coniferous forest >100 years old, >19.4 m tall and <1370 m). The long-term owl habitat areas (LTOHAs) define where, over the long term, the minimum 67% suitable habitat target will be maintained or restored within each WHA. The forest management areas (FMAs) define where, over the long term, timber harvesting can occur to reduce the amount of suitable habitat as low as the 67% habitat target for the WHA.

General wildlife measures

Goals

1. Protect known nest and roost areas. Recruit suitable nesting and roosting habitat and habitat structures.
2. Minimize disturbance at known nesting and roosting sites.
3. Maximize forest interior habitat.
4. Create, enhance, or maintain suitable habitat (i.e., multi-layered, variable density, multi-species stand structure with canopies dominated by dominant and co-dominant trees within areas).
5. Maintain important habitat features (e.g., coarse woody debris, wildlife trees, interior forest, large diameter trees, moderate to high canopy closure; see Table 2).
6. Maintain or enhance habitat for prey species.

Measures

Access

- Do not construct, modify, or deactivate roads or landings within the core area. Where approved, do not construct, modify or deactivate between 1 March and 31 July.
- Minimize road clearing widths to ≤3 m between the timbers edge and either the toe of the fill or the top of the cut, unless no other practicable option exists.

Harvesting and silviculture

- Do not harvest or salvage within core area(s).
- Do not salvage in the management zone.
- Do not remove non-timber forest products.
- Maintain or restore at least 67% of the gross forested area within the WHA in suitable owl habitat of which 75% should be maintained or restored as superior habitat (>140 years, >19.4 m tall and <1370 m). When there is <67%, do not harvest the next oldest age class and/or stands that best achieve Spotted Owl habitat distribution objectives. Heavy volume removal is permitted within the FMA when WHA includes >67% suitable habitat.
- Distribute the 67% suitable habitat into large unfragmented patches >500 ha that are connected by movement corridors of suitable habitat that are a minimum of 1 km wide.
- When harvesting in the management zone (LTOAC and FMA) implement the following measures:
  - Patch cuts (0.05–0.5 ha in size) can represent no more than 5% of the prescribed cut block. Patch cuts must be minimum 100 m (edge to edge) from adjacent patch cuts, clearcuts or natural openings >0.25 ha in size.
  - Remove up to one-third of the basal area from each 10 cm stand diameter class distributed evenly across the treatment area.
  - Retention of trees should be relatively evenly distributed throughout cut blocks. Timber extraction corridors will not exceed the average inter-tree spacing requirement of the treatment area as described in Table 3.
  - For cut blocks within CWHds1, CWHms1, CWHms2, MHmm2, ESSFmw, and IDFww, maintain or create on average 5 snags >30 cm dbh/ha and maintain existing coarse woody debris, and add 25 cubic m/ha of unmerchantable logs >30 cm dbh.
  - For cut blocks within CWHdm, CWHvm1, CWHvm2 and MHmm1, maintain or create on average 5 snags >50 cm dbh/ha and maintain existing coarse woody debris, and add 25 cubic m/ha of unmerchantable logs >50 cm dbh.

Table 3. Average corridor width spacing requirements for partial harvests

Retention of dominant trees/ha	Average corridor widths
173	7.6 m
200	7.0 m
250	6.3 m
300	5.8 m
400	5.0 m
500	4.5 m
625	4.0 m
800	3.5 m
1000	3.2 m

Pesticides

- Do not use pesticides.

Within the FMA

- Locate cut blocks in areas that minimize impacts to suitable habitat objectives and Spotted Owls activity.
- Maintain a minimum of 10% wildlife tree retention areas. Wildlife tree retention areas that consist of non-suitable habitat may be enhanced utilizing partial harvest.
- Maintain or create on average 5 snags >76 cm dbh/ha in CWHdm, CWHvm1, CWHvm2 and MHmm1, or maintain or create on average 5 snags >51 cm dbh/ha in the CWHds1, CWHms1, CWHms2, MHmm2, ESSFmw, and IDFww.
- For cut blocks within CWHds1, CWHms1, CWHms2, MHmm2, ESSFmw, and IDFww, there should be an average of 40 windfirm leave trees maintained from the top 80 largest diameter trees/ha.
- For cut blocks within CWHdm, CWHvm1, CWHvm2, and MHmm1, there should be an average of 15 windfirm leave trees maintained from the top 30 largest diameter trees/ha.

Information Needs

1. Current range and distribution in the province.
2. Short-term population changes and long-term population demographics.
3. Habitat selection/preference requirements.

Cross References

Bull Trout, Coastal Giant Salamander, Coastal Tailed Frog, Keen's Long-eared Myotis, Marbled Murrelet, Pacific Water Shrew

References Cited

Barrowclough, G. and R. Gutierrez. 1990. Genetic variation and differentiation in the spotted owl (*Strix occidentalis*). Auk 107(4):737–744.

Blackburn, I., A. Harestad, J. Smith, S. Godwin, R. Hentze, and C. Lenihan. 2002. Population assessment of the northern spotted owl in British Columbia 1992–2001. B.C. Min. Water, Land and Air Prot., Surrey, B.C.

Blackburn, I. and S. Godwin. 2003. The Status of the Northern Spotted Owl (*Strix occidentalis caurina*) in British Columbia. B.C. Min. Water, Land and Air Prot., Surrey, B.C.

Blakesley, J., Franklin, A., and R, Gutierrez. 1990. Sexual dimorphism in Northern Spotted Owls from northwest California. Journal of Field Ornithology, 61 (3), 320-327.

B.C. Ministry of Water, Land and Air Protection (MWLAP). 2003. Regional Spotted Owl database. Surrey, B.C.

Buchanan, J.B., L.L Irwin, and E.L. McCutchen. 1993. Characteristics of Spotted Owl nest trees in the Wenatchee National Forest. J. Raptor Res. 27(1):1-7.

Buchanan, J.B., L.L. Irwin, and E.L. McCutchen. 1995. Within-stand nest site selection by Spotted Owls in the eastern Washington Cascades. J. Wildl. Manage. 59:301–310.

Carey, A., S. Horton, and B. Biswell. 1992. Northern spotted owls: influence of prey base and landscape character. Ecol. Monogr. 62(2):223–250.

Committee on the Status of Endangered Wildlife in Canada (COSEWIC). 2002. Canadian Species at Risk. www.speciesatrisk.gc.ca

Dawson, W., J. Ligon, J. Murphy, J. Myers, D. Simberloff, and J. Verner. 1986. Report of the scientific advisory panel on the spotted owl. Condor 89:205–229.

Dunbar, D. L., B. P. Booth, E. D. Forsman, A. E. Hetherington and D. J. Wilson. 1991. Status of the Spotted Owl (*Strix occidentalis*) and Barred Owl (*Strix varia*) in Southwestern British Columbia. Can. Field-Nat. 105:464-468.

Dunbar, D. and I. Blackburn. 1994. Management options for the northern spotted owl in British Columbia. B.C. Environ., Surrey, B.C.

Forsman, E., R. Anthony, J. Reid, P. Loschl, S. Sovern, M. Taylor, B. Biswell, A. Ellingson, C. Meslow, G. Miller, K. Swindle, J. Thrailkill, F. Wagner, and E. Seaman. 2002. Natal and breeding dispersal of Northern Spotted Owls. Wildl. Monogr. 149:1-35.

Forsman, E., A. Giese, D. Herter, D. Manson, and S. Sovern. 1995. Renesting by spotted owls. Condor 97:1078–1080.

Forsman, E. and A. Giese. 1997. Nests of northern spotted owls on the Olympic Peninsula, Washington. Wilson Bull. 109(1):28–41.

Forsman, E., C. Meslow, and H. Wight. 1984. Distribution and biology of the spotted owl in Oregon. Wildl. Monogr. 87:1–64.

Forsman, E., I. Otto, S. Sovern, M. Taylor, D. Hays, H. Allen, S. Roberts, and E. Seaman. 2001. Spatial and temporal variation in diets of Spotted Owls in Washington. J. Raptor Res. 35(2):141-150.

Franklin, A. B., K. P. Burnham, G. C. White, R. G. Anthony, E. D. Forsman, C. Schwarz, J. D. Nichols, and J. Hines. 1999. Range-wide status and trend in northern Spotted Owl populations. Colorado State Univ. and Oregon State Univ., Fort Collins, Colo. Unpubl. report.

Hamer, T.E., S.G. Seim and K.R. Dixon. 1989. Northern spotted owl and northern barred owl habitat use and home range size in Washington. Preliminary report, Washington Department of Wildlife. 65 pp.

Hanson, E., D.W. Hays, L. Hicks, L. Young, and J. Buchanan. 1993. Spotted owl habitat in Washington. Washington Forest Practices Board. Washington. 115 pp.

Hobbs, J. 2002. Spotted Owl nest searches in the Lillooet forest district – 2002: Summary of results. B.C. Min. Water, Land and Air Prot.. Biodiversity Br., Victoria, B.C. Unpubl.

Horoupian, N., C. Lenihan, A. Harestad, and I. Blackburn. 2000. Diet of northern spotted owls in British Columbia. Simon Fraser Univ., Dep. Biol. Sci., Burnaby, B.C. Unpubl. manuscript.

Kelly, L.G. 2001. The range expansion of the northern barred owl: an evaluation of the impact on spotted owls. Thesis, Oregon State Univ., Corvallis, Oreg. 78 pp.

Laing, H. 1942. Birds of the coast of central British Columbia. Condor. 44:175-181.

Miller G., R. Small, and C. Meslow. 1997. Habitat selection by Spotted Owls during natal dispersal in western Oregon. J. Wildl. Manage. 61(1):140-150.

NatureServe Explorer. 2002. An online encyclopedia of life [web application]. Version 1.6. Arlington, Virgina. Available: http://www.natureserve.org/explorer.

Ransome, D. 2001. Population Ecology and Resource Limitation of Northern Flying Squirrels and Douglas Squirrels. Ph. D. Thesis. Faculty of Graduate Studies Dep. For. Univ. British Columbia, B.C. 106 p.

Spotted Owl Management Inter-Agency Team (SOMIT). 1997. Spotted owl management plan: Strategic component. B.C. Min. Environ., Lands and Parks and B.C. Min. For., Victoria, B.C.

Thomas, J., E. Forsman, J. Lint, E. Meslow, B. Noon, and J. Verner. 1990. A conservation strategy for the northern spotted owl. Interagency scientific committee to address the conservation of the northern spotted owl, Portland, Oreg.

U.S. Department of the Interior (USDI). 1992. Recovery plan for the northern spotted owl –draft. Fish Wildl. Serv., Washington, D.C.

Wilcove, D. 1987. Public lands management and fate of the spotted owl. Amer. Birds 41(3):361–367.

Personal Communications

Dunbar, D. 2001. Min. Water, Land and Air Protection, Surrey, B.C.

Hilton, A. 2001. Panorama Wildlife Research, Surrey, B.C.

WHITE-HEADED WOODPECKER

Picoides albolarvatus

Original[1] prepared by Martin Gebauer

Species Information

Taxonomy

The White-headed Woodpecker is currently placed in the genus *Picoides*, a genus poorly understood phylogenetically and subject to frequent revisions over the years (Garrett et al. 1996). Eight other *Picoides* species occur in North America: Ladder-backed (*P. scalaris*), Red-cockaded (*P. borealis*), Nuttall's (*P. nuttallii*), Strickland's (*P. stricklandi*), Downy (*P. pubescens*), Hairy (*P. villosus*), Three-toed (*P. tridactylus*), and Black-backed (*P. arcticus*) woodpeckers (AOU 1998).

Two subspecies of White-headed Woodpecker are recognized: one occurring in the mountains of southern California (*P. albolarvatus gravirostris*), and the other from British Columbia to the Sierra Nevada in central California (*P. albolarvatus albolarvatus*) (Garrett et al. 1996; Cannings 1998).

Description

The White-headed Woodpecker is unique among North American woodpeckers in having entirely black body plumage and tail, with only the face, throat, crown, and large patch at the base of the primaries white. Males have a red patch at the back of the head; juvenile males have a variable patch of red on the crown (Garrett et al. 1996; NGS 1999).

Clark's Nutcracker (*Nucifruga columbiana*), a corvid with pale grey head, and woodpecker-like bill and behaviour, is occasionally mistaken for the White-headed Woodpecker (Cannings 2000).

Distribution

Global

The White-headed Woodpecker is restricted to western North America, ranging from extreme southcentral British Columbia southward, primarily east of the Cascades, to southern California (Garrett et al. 1996).

British Columbia

The White-headed Woodpecker is a very rare resident in the Okanagan Valley from Naramata south, and occasionally resides in the Similkameen Valley, Grand Forks area, and the Kootenays (Weber and Cannings 1976; Cannings et al. 1987; Campbell et al. 1988; Campbell et al. 1990). Sightings in suitable habitat have also been reported from Lytton, Manning Park, Bummers Flats north of Cranbrook, and south of Golden but have not been substantiated by detailed descriptions or photos (Weber and Cannings 1976; Campbell et al. 1990).

Forest region and districts

Southern Interior: Arrow Boundary, Cascades, (incidental – Kootenay Lake), Okanagan Shuswap

Ecoprovinces and ecosections

SIM: SCM, SFH

SOI: OKR, SOB, SOH, NOB, NOH, (incidental – NTU, STU, THB)

Biogeoclimatic units

BG: xh (breeding)

ESSF: mc, mk, mm, mv, mw (very incidentally if at all—only 2% of sightings)

ICH: dw (very incidentally if at all—only 2% of sightings)

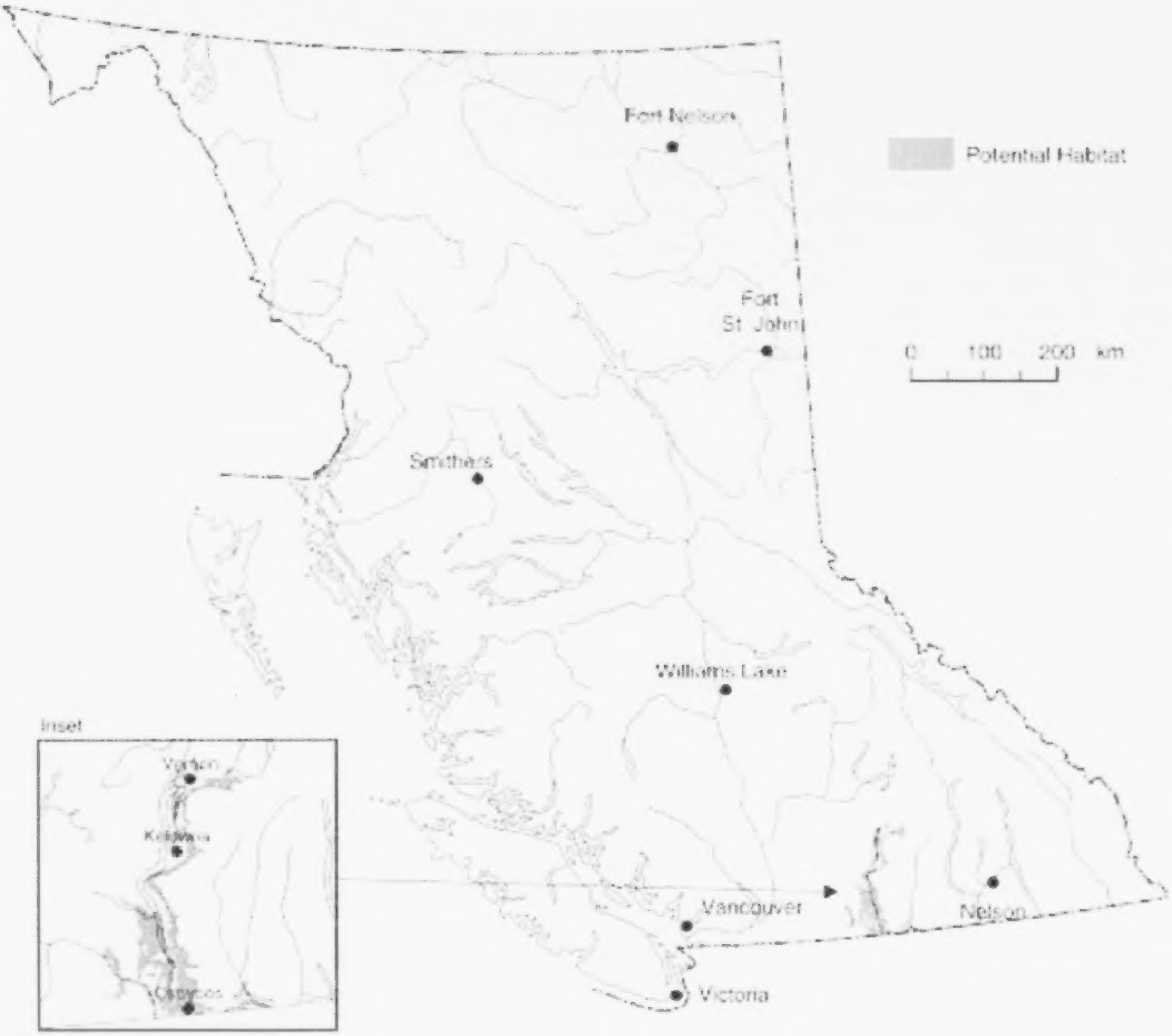
IDF: dk, dm, xh, xm, xw (very incidentally)

---

[1] Volume 1 account prepared by T. Manning and V. Stevens.

White-headed Woodpecker

(Picoides albolarvatus)


Fort Nelson
Potential Habitat
Fort St. John
0 100 200 km
Smithers
Williams Lake
Inset
Vernon
Kelowna
Osoyoos
Vancouver
Nelson
Victoria

Note: This map represents a broad view of the distribution of potential habitat used by this species. The map is based on several ecosystem classifications (Ecoregion, Biogeoclimatic and Broad Ecosystem Inventory) as well as current knowledge of the species' habitat preferences. This species may or may not occur in all areas indicated.

MS: dc, xk (very incidentally if at all—only 2% of sightings)

PP: xh (breeding)

Broad ecosystem units

DP, PP, (very rarely uses DL, ER, EF, and LP in BC; not common in DF)

Elevation

350 to 1300 m; rarely seen above 1000 m

Life History

Diet and foraging behaviour

In early summer, the White-headed Woodpecker forages for insects mainly on the lower portions of large, live ponderosa pine (*Pinus ponderosa*) trees in the puzzle bark stage (>60 cm dbh) (Dixon 1995b; Garrett et al. 1996). However, insects (ants, wood-boring beetles, spiders, fly larvae) make up a small proportion of the diet relative to other *Picoides* woodpeckers (Ligon 1973; MELP 1998). For most of the year, White-headed Woodpecker forages primarily for seed in the cones of ponderosa pine. Ponderosa pine seeds are generally only available in late summer and fall, except in years with heavy cone crops (Dahms and Barrett 1975). Pine seeds are a major source of food throughout the range of White-headed Woodpecker (Bent 1939; Curtis 1948; Koch et al. 1970; Ligon 1973).

When foraging for insects on conifer trunks or branches, the White-headed Woodpecker flakes and chips bark away rather than striking the wood directly like some woodpeckers (Ligon 1973). It generally flies to the bottom of a tree and works its way to the top while feeding (Bent 1939). Other foraging behaviours are varied and include gleaning foliage in terminal needle clusters (Ligon 1973; Raphael and White 1984), scratching bark loose with its feet (Ligon 1973), feeding on stalks of great mullein (*Verbascum thapsus*) (Weber and Cannings 1976), and visiting suet feeders (Cannings et al. 1987). Compared with the Hairy Woodpecker, the White-headed Woodpecker fed more on living trees, consistent with their habit of gleaning rather than drilling and excavating (Morrison and With 1987).

Reproduction

The White-headed Woodpecker is a primary excavator, making its cavities in dead or dying trees, with a preference for large ponderosa pine (usually >60 cm dbh) (Thomas 1979; Dixon 1995a; Dixon 1995b). Typically a new nest cavity is excavated each year but in exceptional cases a cavity may be reused (Garrett et al. 1996).

In British Columbia, eggs have been found in nests from mid-May to mid-June. Clutch size ranges from three to nine eggs (av. 4–5). The incubation period usually lasts for 14 days. In British Columbia, young have been recorded at nests from 30 May to 16 July (Campbell et al. 1990). Nestlings may fledge as early as late June. Typically there is one brood per breeding season.

Site fidelity

Pairs of White-headed Woodpecker do not exhibit much site fidelity from year to year in British Columbia, often breeding at a site for only 1–2 years and then moving on (Cannings 2000). No information is available on where breeding pairs move and whether the same breeding areas are reused.

Home range

No information on home range or territory size of White-headed Woodpecker exists for British Columbia. Breeding territories averaged 104 ha in continuous old-growth pine forest and 321 ha in fragmented sites in central Oregon (Garrett et al. 1996), suggesting that breeding territories in British Columbia, where much of remaining ponderosa pine forest is fragmented, may be larger than in other areas of the range.

Movements and dispersal

The White-headed Woodpecker is at the northern limit of its distribution in the southern Interior. It is considered a year-round resident in British Columbia and has a relatively even distribution of observations by month (Weber and Cannings 1976; Cannings et al. 1987). Because of the small resident population and few sightings in British Columbia, seasonal movement and dispersal patterns are not known, although, presumably young birds wander in search of breeding areas. It is likely that populations in the Okanagan could increase after a year of high breeding success in Washington State as young birds disperse northwards. Records of this species at higher elevations and outside the Okanagan Valley are likely the result of these dispersal movements.

Habitat

Structural stage

6: mature forest
7: old forest

Important habitats and habitat features

The White-headed Woodpecker prefers mature and old forests (i.e., structural stage classes 6–7) (Mannan and Meslow 1984). These forests are structurally complex, typically contain snags and coarse woody debris at all stages of decomposition, and have open or patchy understoreys.

Nesting

Only seven nest cavities have been found in British Columbia. Of these, five were in ponderosa pine (live and dead), one nest was found in Douglas-fir (*Pseudotsuga menziesii*), and one in a stump (Campbell et al. 1990). Of 43 nests found in central Oregon, 36 were in ponderosa pine (*Pinus ponderosa*) snags, 2 in ponderosa pine stumps, 2 in aspen (*Populus tremuloides*) snags, and 1 each in live quaking aspen, white-fir (*Abies concolor*) snag, and dead top of live ponderosa pine tree (Dixon 1995b).

The more decayed, large diameter snags (wildlife tree classes 5–6), often with broken tops, are preferred trees for nesting. Leaning or broken-topped snags or stumps are commonly used as nest trees, often where heart rot has created a soft interior but left the exterior hard. Raphael and White (1984) found that White-headed Woodpeckers nested in the oldest snags with advanced decay. Similarly, Milne and Hejl (1989) found only six of 176 nest sites in live trees. In south-central Oregon, 37% of the nest trees were in snags, 56% in stumps, and 6% in leaning logs ($n = 16$) (Dixon 1995a). The majority of nests found in central Oregon were in moderately decayed substrates (Dixon 1995a). See Table 1 for nest tree characteristics of White-headed Woodpeckers.

The nest cavities in British Columbia ranged in height from 2.4 to 9 m above ground (Cooper 1969; Cannings et al. 1987; Campbell et al 1990). In the Sierra Nevada, Raphael and White (1984) found that White-headed Woodpecker nested at low heights (i.e., 1.9 m) compared with other cavity nesters. High-cut stumps were readily used for nesting in California (Morrison et al. 1983).

According to Thomas (1979), the White-headed Woodpecker has a requirement for high snag densities, with 558 snags/100 ha (or about 45 snags/territory) needed for maximum population densities. Most nests were found in large trees ranging in size from a mean dbh of 56 cm in west-central Idaho (Frederick and Moore 1991), to 65 cm in central Oregon (Dixon 1995a; Dixon 1995b) and 73 cm in the Sierra Nevada, California (Milne and Hejl 1989). Most of the White-headed Woodpecker nests found by Raphael and White (1984) in the Sierra Nevada were <50 cm dbh.

All seven nests found in British Columbia were found in relatively open-canopied stands (<70% canopy cover) of mature ponderosa pine forest from 450 to 600 m elevation, with most located in or on the edge of forest clearings (Campbell et al. 1990). Milne and Hejl (1989) found that the White-headed Woodpecker tended to nest in open-canopied stands with 40% of nests in stands with <42% cover and 42% in stands with 41–69% forest cover. Dixon (1995a) found forests with canopies >51% to be selected by White-headed Woodpecker in Oregon. In central Oregon, mean canopy closure was 24% at nests and 44% at roosts. The majority of nests were in partial cut old-growth (31%) and overstorey removal (44%) ponderosa pine stands; the majority of roosts were in uncut and partial-cut old-growth ponderosa pine stands (70%) (Dixon 1995a).

Roosting

Roosts were located in cavities, under sloughing bark of large ponderosa pine, and in cracks and crevices of trunks (Dixon 1995a; Garrett et al. 1996).

Information on roosting requirements for this species in British Columbia is lacking.

Foraging

In British Columbia and throughout its range, White-headed Woodpecker appears to be very dependent on ponderosa pine, particularly stands with a significant mature or old-growth component (Garrett et al. 1996). In British Columbia, the White-headed Woodpecker forages in open ponderosa pine and mixed pine – Douglas-fir forests up to 1000 m elevation, very rarely moving into Engelmann spruce (*Picea engelmannii*) – lodgepole pine (*Pinus contorta*) forests up to 1300 m. White-headed Woodpecker appears most abundant where more than one species of large-seeded pine is present (Garrett et al. 1996).

Of 115 British Columbia sightings reviewed by Weber and Cannings (1976), 85% were in ponderosa pine forests, 5% in ornamental gardens (primarily at feeders), 4% in mixed ponderosa pine/Douglas-fir forests, 3% in Douglas-fir forests, 2% in Engelmann spruce/lodgepole pine forest, and 1% in a black cottonwood (*Populus balsamifera*) stand. In other areas of their range, White-headed Woodpeckers have been found at higher densities in mixed-conifer forests (Beedy 1981; Raphael and White 1984; Milne and Hejl 1989), but mature ponderosa pine forest is still extremely important (Thomas 1979). Foraging habitat in central Oregon was mainly in ponderosa pine habitat with mean canopy closure of 54%, and a mean shrub cover of 25% (Dixon 1995a). In this area, White-headed Woodpeckers spent 79% of their time foraging on live trees with a mean dbh of 74 cm.

Conservation and Management

Status

The White-headed Woodpecker is on the provincial *Red List* in British Columbia. It is designated as *Endangered* in Canada (COSEWIC 2002).

Summary of ABI status in BC and adjacent jurisdictions (NatureServe Explorer 2002)

BC	WA	ID	Canada	Global
S1	S3	S2B, S2N	N1	G4

Trends

Population trends

In British Columbia, White-headed Woodpecker populations have apparently fluctuated widely this century with population peaks in the 1960s and 1970s (Campbell et al. 1990). Campbell et al. (1990) reported only five records of this species between the 1890s and 1950, 15 in the 1950s, 112 in the 1960s, 68 in the 1970s and only 16 between 1980 and 1987. Very few sightings of White-headed Woodpeckers have been reported between 1987 and 2001. Recent breeding records come from the Rock Creek-Bridesville area just east of Anarchist Mountain (1998 and 1999) and a few kilometres northwest of Oliver (1998) (Cannings 2000). Recent surveys by Preston (1990), Joy et al. (1995), and Ramsay (1997) failed to locate any individuals, although Gyug (1996) reported two near Naramata. The decline in

Table 1. Characteristics (mean) ±SD of White-headed Woodpecker nest trees from three locations

Location	Forest type	*n*	dbh (cm)	Height (m)	Nest height (m)	Citation
South-central Oregon	Ponderosa pine	16	80 ± 32	3 ± 4	3 ± 4	Dixon 1995a
Idaho	Ponderosa pine	6	56		2.8	Frederick and Moore 1991
Central Oregon	Ponderosa pine	43	65	14	4.4	Dixon 1995b

woodpecker sightings is apparent despite an increasing number of naturalists and surveys looking for this species.

Based on the absence of population trends indicated from Breeding Bird Survey (Sauer et al. 1999) and Christmas Bird Count (Sauer et al. 1996) data, White-headed Woodpecker populations across their range appear to be stable over the last 30 years (Garrett et al. 1996). Populations in Oregon and Idaho have declined due to habitat loss caused by logging (Garrett et al. 1996).

Habitat trends

Of the approximately 27 500 ha of ponderosa pine–dominated forests in the south Okanagan and lower Similkameen valleys, only about 9500 ha (~ 35%) are classified as old forest, compared with the mid-1800s when the percentage old forest was likely in excess of 75% (Cannings 2000). Summaries of merchantable ponderosa pine in the British Columbia interior indicated that 3 921 450 m^3 was available in 1917, compared with only 715 761 m^3 by 1957 (Cannings 2000).

Threats

Population threats

The White-headed Woodpecker has a small population (estimated <100 pairs) in British Columbia (Cannings 2000). The long-term viability of the population is likely dependent on the breeding success of birds in Washington State and their dispersal north to British Columbia.

Habitat threats

The greatest threat to the White-headed Woodpecker in British Columbia is the ongoing loss of old ponderosa pine due to forest harvesting and urbanization (Garrett et al. 1996; Fraser et al. 1999). Old pine forests provide snags for nesting and roosting and cones for foraging. Seed production appears to be a particularly important habitat component for White-headed Woodpecker. Reductions of mature, cone-producing ponderosa pine stands could jeopardize critical winter food supplies. Ponderosa pine only produce heavy cone crops beginning at 60–100 years of age and at 4–5 year intervals in the Pacific Northwest (Oliver and Ryker 1990). As a result of logging and subsequent fire suppression, many ponderosa pine forests in the Okanagan are characterized by dense stands of young trees (Cannings et al. 1998; Turner and Krannitz 2001), presumably resulting in poor cone production. Most seeds are produced by large, dominant trees in open situations (Dahms and Barrett 1975).

Firewood cutting can also remove suitable trees for nesting and foraging (Scott and Oldemeyer 1983; Garrett et al. 1996; MELP 1998; Fraser et al. 1999).

Due to its partially insectivorous food habits, the White-headed Woodpecker is potentially affected by pesticide applications in breeding and foraging habitat (Cannings 1995; Fraser et al. 1999).

Legal Protection and Habitat Conservation

The White-headed Woodpecker, its nests, and its eggs are protected in Canada and the United States from hunting and collecting under the *Migratory Birds Convention Act*. In British Columbia, the same are protected by the provincial *Wildlife Act*.

The total area of potentially suitable habitat in the south Okanagan is 66 000 ha (MELP 1998) of which 9% is within lands managed for conservation, 42% is on provincial Crown land, 28% on Indian Reserve lands, and 21% on private land. Additional suitable habitat found east (Princeton) and west (Grand Forks and Kootenays) of the south Okanagan likely amounts to no more than 40 000 ha (Cannings 2000).

Habitat is protected within provincial parks and within lands managed and owned by the Nature Trust and the Ministry of Water, Land and Air Protection. The greatest portion of protected lands within the range of White-headed Woodpecker is in Okanagan Mountain Provincial Park (10 542 ha). Other protected areas include the Vaseux-Bighorn National Wildlife Area and various properties owned by the Nature Trust around Vaseux Lake. A number of new protected areas that have been announced in the south Okanagan through the Okanagan-Shuswap Land and Resource Management Plan process should result in an additional 5716 ha of potential protected habitat. Some of the more important parks for White-headed Woodpeckers include White Lake Grasslands (3627 ha), South Okanagan Grasslands (9700 ha), Anarchist, Vaseux, and Adra Tunnel.

Under the results based code, the riparian and old forest retention guidelines provide some protection of habitat for this species. Old growth management areas (OGMAs) in the ponderosa pine zone, in particular, will protect important habitats for the White-headed Woodpecker. Current policy, however, directs the establishment of OGMAs to be established within the non-timber harvesting land base wherever possible. Therefore the potential overlap between OGMAs and suitable habitat for the White-headed Woodpecker is currently unknown.

Identified Wildlife Provisions

Sustainable resource management and planning recommendations

Since this species prefers wildlife trees and mature and old forest, it is best managed at the landscape level through wildlife tree and old forest retention objectives.

- Maintain high suitability habitat (i.e., ponderosa pine, structural stages 6 or 7) in patches between 20 and 1000 ha. Because of this species' relatively large home range size (100–400 ha), larger patches are more suitable.
- Maximize connectivity between suitable habitats. Linkages should be composed of large areas of connecting habitats, rather than merely corridors (e.g., relatively large reserve areas containing drier, open-canopied mature and old ponderosa pine).
- Blocks should be assessed to identify potentially suitable wildlife tree retention areas. Table 2 provides recommendations for selecting wildlife tree retention areas designed to meet the needs of the White-headed Woodpecker.

Table 2. Preferred wildlife tree retention area features for the White-headed Woodpecker

Attribute	Preference
Size (ha)	≥8 ha
Location	350–750 m in elevation, PPxh
Tree features	leaning or broken-tops; heartrot
Tree species	ponderosa pine, aspen, Douglas-fir
Wildlife tree class	5 and 6
Tree size (dbh)*	≥80 cm where available; ≥45 cm for recruitment

* After Dixon 1995a.

Wildlife habitat area

Goal

Maintain historic, current and future suitable nesting habitat.

Feature

Establish WHAs at, or close to, known occurrences within suitable habitat or habitats that will provide the desired attributes in a short time period if the attributes do not currently exist.

Size

Typically between 20 to 80 ha.

Design

A WHA should include mature or old ponderosa pine forest, preferably with 40–70% canopy closure where it exists, but can range from 6 to 75% (i.e., crown closure classes 1–7) with a mix of large (≥60 cm dbh preferred, minimum 25 cm dbh) live and standing dead trees (i.e., ponderosa pine, Douglas-fir, aspen; lodgepole pine and Engelmann spruce) suitable for nesting.

General wildlife measures

Goals

1. Provide and recruit an adequate supply of suitable large diameter live and dead wildlife trees for foraging and nesting.
2. Maintain mature or old stand structure with open canopy.
3. Maintain mature cone-producing ponderosa pine to ensure non-breeding food supplies.
4. Minimize new access development (i.e., roads) to prevent habitat fragmentation and to reduce firewood cutting.

Measures

Access

- Do not construct roads. Deactivate and/or close temporary roads immediately after logging.

Harvesting and silviculture

- Do not salvage timber. When harvesting is approved follow the measures below.
- Protect and retain all ponderosa pine live and dead trees ≥50 cm dbh. Ensure recruitment of ponderosa pine >50 cm dbh.
- Maintain at least six standing dead trees/ha. Where it is not possible to retain six ≥60 cm, use the largest available. The highest practical density of snags is preferred. Hazardous snags or trees can be incorporated into group reserves (plan as no work zones if appropriate); otherwise, maintain snags within the operational setting as described in the *Wildlife/Danger Tree Assessor's Course Workbook*.
- Use partial cutting silvicultural systems to maintain 40–70% canopy cover, late seral ponderosa pine. On average, removal should be 35% but may be greater where Douglas-fir makes up a greater percentage of the stand. Group selection (openings 0.5 ha), with group reserves, or single tree selection with group reserves are the recommended silvicultural systems.
- Thin young stands to maximize growth and cone production of retained trees. When thinning, retain aspen.
- Replant with ponderosa pine.

Pesticides

- Do not use pesticides.

Additional Management Considerations

Suitable habitat could be created in currently marginal habitats using a number of forest management practices. Areas selected for enhancement should have a high density of young to mature ponderosa pine and ideally be linked to other areas of potentially suitable habitats. Potential enhancement techniques could include thinning to create an open-canopied stand leaving the largest and oldest trees, and prescribed burning to reduce densities of shade-tolerant Douglas-fir, stimulate cone production, and mimic natural cycling of the ecosystem (Joy et al. 1995).

In actively harvested areas outside of WHAs, consideration should be given to retaining all snags and a component of mature pines. Snags are an important component of the ecosystem for woodpeckers and will gradually be lost and may not be replaced under current forest management practices (Ohmann et al. 1994). Buffers around each snag would address safety concerns and provide potential habitat for woodpeckers and other wildlife. Where buffers are not possible, leaving high-cut stumps may be an option (Ohmann et al. 1994; Joy et al. 1995). Morrison et al. (1983) found that high cut stumps in Tahoe National Forest, California, were readily accepted as nest locations by White-headed Woodpecker.

Stand-replacement fires destroy potential habitats for White-headed Woodpecker. On the other hand, frequent ground fires reduce the young tree component of the forest, and will eventually lead to open stands dominated by mature and old-growth trees. Prescribed burning in potential White-headed Woodpecker habitats is an excellent habitat enhancement tool.

Additional potential nest sites in intensely managed stands may be provided by leaving some high-cut (5 m in height) stumps of large (≥60 cm dbh) ponderosa pine.

Information Needs

1. Specific habitat preferences, both botanical and structural, as well as territory size and basic population demographics of White-headed Woodpecker (Garrett et al. 1996; Fraser et al. 1999; Krannitz and Gebauer 2003).
2. The impacts of fire suppression and the effectiveness of using prescribed burning to improve habitats for White-headed Woodpecker (Turner and Krannitz 2001).

Cross References

Lewis's Woodpecker

References Cited

American Ornithologists' Union (AOU). 1998. Check-list of North American birds, 7th ed. Washington, D.C. 829 p.

Beedy, E.C. 1981. Bird communities and forest structure in the Sierra Nevada of California. Condor 83:97–105.

Bent, A.C. 1939. Life histories of North American woodpeckers. U.S. Natl. Mus. Bull. 3.

B.C. Ministry of Environment, Lands and Parks (MELP). 1998. Habitat atlas for wildlife at risk: South Okanagan & Lower Similkameen. Penticton, B.C.

Campbell, R.W., N.K. Dawe, I. McTaggart-Cowan, J.M. Cooper, G.W. Kaiser, and M.C.E. McNall. 1990. The birds of British Columbia. Vol. II: Nonpasserines. Diurnal birds of prey through woodpeckers. Royal B.C. Mus., Victoria, B.C., and Can. Wildl. Serv., Delta, B.C.

Campbell, R.W., K.H. Morgan, and C. Palmateer. 1988. Species notes for selected birds. Vol. 2 *in* Wildlife habitat handbooks for the Southern Interior Ecoprovince. A.P. Harcombe (technical editor). B.C. Min. Environ. and B.C. Min. For., Victoria, B.C. 135 p.

Cannings, R.A., R.J. Cannings, and S.G. Cannings. 1987. Birds of the Okanagan Valley, British Columbia. Royal B.C. Mus., Victoria, B.C.

Cannings, R.J. 1995. Status report on the White-headed Woodpecker, *Picoides albolarvatus*, in British Columbia. B.C. Min. Environ., Victoria, B.C. Wildl. Bull. B-80.

_____. 1998. The birds of British Columbia: a taxonomic catalogue. B.C. Min. Environ., Lands and Parks, Wildl. Br., Resour. Inventory Br., Victoria, B.C. Wildl. Bull. B-86.

_____. 2000. Update COSEWIC Status Report on White-headed Woodpecker (*Picoides albolarvatus*). Committee on the Status of Endangered Wildlife in Canada, Ottawa, Ont.

Cannings, R.J., E. Durance, and L. Scott. 1998. South Okanagan Ecosystem Recovery Plan: scientific assessment. B.C. Min. Environ., Lands and Parks, Penticton, B.C. Unpubl. rep.

Committee on the Status of Endangered Wildlife in Canada (COSEWIC). 2002. Canadian Species at Risk. www.speciesatrisk.gc.ca

Cooper, J.K. 1969. First breeding record of the White-headed Woodpecker in Canada. Can. Field-Nat. 83:276–277.

Curtis, J.D. 1948. Animals that eat ponderosa pine seed. J. Wildl. Manage. 12:327–328.

Dahms, W.G. and J.W. Barrett. 1975. Seed production of central Oregon ponderosa and lodgepole pines. U.S. Dep. Agric. For. Serv., Res. Pap. PNW-191.

Dixon, R.D. 1995a. Density, nest-site and roost-site characteristics, home-range, habitat-use, and behaviour of White-headed Woodpeckers: Deschutes and Winema National Forests, Oregon. Oreg. Dep. Fish Wildl. Nongame Rep. 93-3-01.

_____. 1995b. Ecology of White-headed Woodpeckers in the central Oregon Cascades. M.S. thesis. Univ. Idaho, Moscow, Idaho.

Fraser, D.F., W.L. Harper, S.G. Cannings, and J.M. Cooper. 1999. Rare birds of British Columbia. B.C. Min. Environ., Lands and Parks, Wildl. Br. and Resour. Inventory Br., Victoria, B.C. 244 p.

Frederick, G.P. and T.L. Moore. 1991. Distribution and habitat of White-headed Woodpecker (*Picoides albolarvatus*) in west central Idaho. Idaho Dep. Fish Game, Conserv. Data Cent., Boise, Idaho.

Garrett, K.L., M.G. Raphael, and R.D. Dixon. 1996. White-headed Woodpecker (*Picoides albolarvatus*). *In* Birds of North America, No. 252. A. Poole and F. Gill (editors). Birds of North America, Inc., Philadelphia, Penn.

Gyug, L.W. 1996. Forest development plan: Red- and Blue-listed species inventory for woodpeckers. B.C. Min. Environ., Lands and Parks, Penticton, B.C. Unpubl. rep.

Joy, J., R. Van den Driessche, and S. McConnell. 1995. 1995 White-headed Woodpecker population and habitat inventory in the South Okanagan. B.C. Min. Environ., Lands and Parks, Penticton, B.C. Unpubl. rep.

Koch, R.F., A.E. Courchesne, and C.T. Collins. 1970. Sexual differences in foraging behaviour of White-headed Woodpeckers. Bull. South. Calif. Acad. Sci. 69:60–64.

Krannitz, P.G. and M. Gebauer. 2003. White-headed Woodpecker Recovery Strategy. Environ. Canada, Delta, B.C.

Ligon, J.D. 1973. Foraging behavior of the White-headed Woodpecker in Idaho. Auk 90:862–869.

Mannan, R.W. and E.C. Meslow. 1984. Bird populations and vegetation characteristics in managed and old-growth forests, northeastern Oregon. J. Wildl. Manage. 48(4):1219–1238.

Milne, K.A. and S.J. Hejl. 1989. Nest-site characteristics of White-headed Woodpeckers. J. Wildl. Manage. 53(1):50–55.

Morrison, M.L., M.G. Raphael, and R.C. Heald. 1983. The use of high-cut stumps by cavity-nesting birds. *In* Snag habitat management: Symp Proc. J.W. Davis, G.A. Goodwin, and R.A. Ockenfels (editors). U.S. Dep. Agric. For. Serv., Gen. Tech. Rep. RM-99, pp. 73–79.

Morrison, M.L. and K.A. With. 1987. Interseasonal and intersexual resource partitioning in Hairy and White-headed woodpeckers. Auk 104:225–233.

National Geographic Society (NGS). 1999. Field guide to birds of North America. Washington, D.C.

NatureServe Explorer. 2002. An online encyclopaedia of life. Version 1.6. NatureServe. Arlington, VA. Available at http://www.natureserve.org/explorer/

Ohmann, J.L., W.C. McComb, and A.A. Zumrawi. 1994. Snag abundance for primary cavity-nesting birds on nonfederal forest lands in Oregon and Washington. Wildl. Soc. Bull. 22:607–620.

Oliver, W.W. and R.A. Ryker. 1990. Ponderosa pine. *In* Sylvics of North America, Volume 1: Conifers. R.M. Burns and B.H. Honkala (editors). U.S. Dep. Agric. For. Serv., Agric. Handb. 654, pp. 413–424.

Preston, A. 1990. Canyon Wren, Sage Thrasher, White-headed Woodpecker, Gray Flycatcher and Grasshopper Sparrows in the South Okanagan. B.C. Min. Environ., Penticton, B.C. Unpubl. rep.

Ramsay, L. 1997. White-headed Woodpecker survey in the South Okanagan, BC (1996 and 1997). B.C. Min. Environ., Lands and Parks, Wildl. Br., Penticton, B.C. Unpubl. rep.

Raphael, M.G. and M. White. 1984. Use of snags by cavity-nesting birds in the Sierra Nevada. Wildl. Monogr. 86. 66 p.

Sauer, J.R., J.E. Hines, I. Thomas, J. Fallon, and G. Gough. 1999. The North American Breeding Bird Survey, results and analysis 1966–1998. Version 98.1. Laurel, Md. Available from: www.mbr-pwrc.usgs.gov/bbs.

Scott, V.E. and J.L. Oldemeyer. 1983. Cavity-nesting bird requirements and responses to snag cutting in ponderosa pine. *In* Snag habitat management: Symp. Proc. J.W. Davis, G.A. Goodwin, and R.A. Ockenfels (editors). U.S. Dep. Agric. For. Serv., Gen. Tech. Rep. RM-99, pp. 19–23.

Thomas, J.W. 1979. Wildlife habitats in managed forests: the Blue Mountains of Oregon and Washington. U.S. Dep. Agric., Washington, D.C. Agric. Handb. 553. 512 p.

Turner, J.S. and P.G. Krannitz. 2001. Conifer density increases in semi-desert habitats of British Columbia in the absence of fire. Northwest Sci. 75:176–182.

Weber, W.C. and S.R. Cannings. 1976. The White-headed Woodpecker (*Dendrocopos albolarvatus*) in British Columbia. Syesis 9:215–220.

YELLOW-BREASTED CHAT

Icteria virens

Original[1] prepared by Martin Gebauer

Species Information

Taxonomy

The Yellow-breasted Chat is the only species of the Tribe Parulini (i.e., wood warblers) in the genus *Icteria* (Sibley 1996). According to Sibley (1996), an additional 119 species of wood warbler are found in the Tribe Parulini worldwide. Although placed in the family Parulidae, its relationship to other avian groups has been controversial over the years, being first described by Linnaeus in the thrush genus *Turdus* (Cannings 2000). Two subspecies of Yellow-breasted Chat are recognized: *I. virens virens* that occurs in southeast Canada and the eastern United States and *I. virens auricollis* that occurs in western North America (Cannings 1998).

Description

The Yellow-breasted Chat is the largest warbler occurring in British Columbia. Upper parts, including the wings and tail, are a uniform greyish olive-green colour, whereas the throat, breast, and underwing coverts are bright yellow. Remaining underparts are white with sides tinged with buffy grey. A bold white stripe from the bill back over the eye is distinct. White patches are also present under the eye and from the base of the bill back over the jaw. Lores are black in males and grey in females. The Yellow-breasted Chat often sings at night, similar to some of the mimic thrushes, and has the lowest voice of any American wood warbler (Aslop 2001). The unmusical song is comprised of a jumble of harsh, clucks, rattles, whistles, and squawks (Godfrey 1986; NGS 1999). Yellow-breasted Chats inhabit dense thickets and brush and are retiring and shy, making them very difficult to observe. Their loud song is often the only indication an observer has of their presence in an area.

Distribution

Global

The Yellow-breasted Chat breeds from southern British Columbia, southern Alberta, southern Saskatchewan, and southern Ontario south through most of the United States to west and central Baja California and the central Mexican mainland (Howell and Webb 1995; Campbell et al. 2001). It winters from southern Baja California, southern Texas, and Florida south to Panama (Howell and Webb 1995; Sauer et al. 2000).

British Columbia

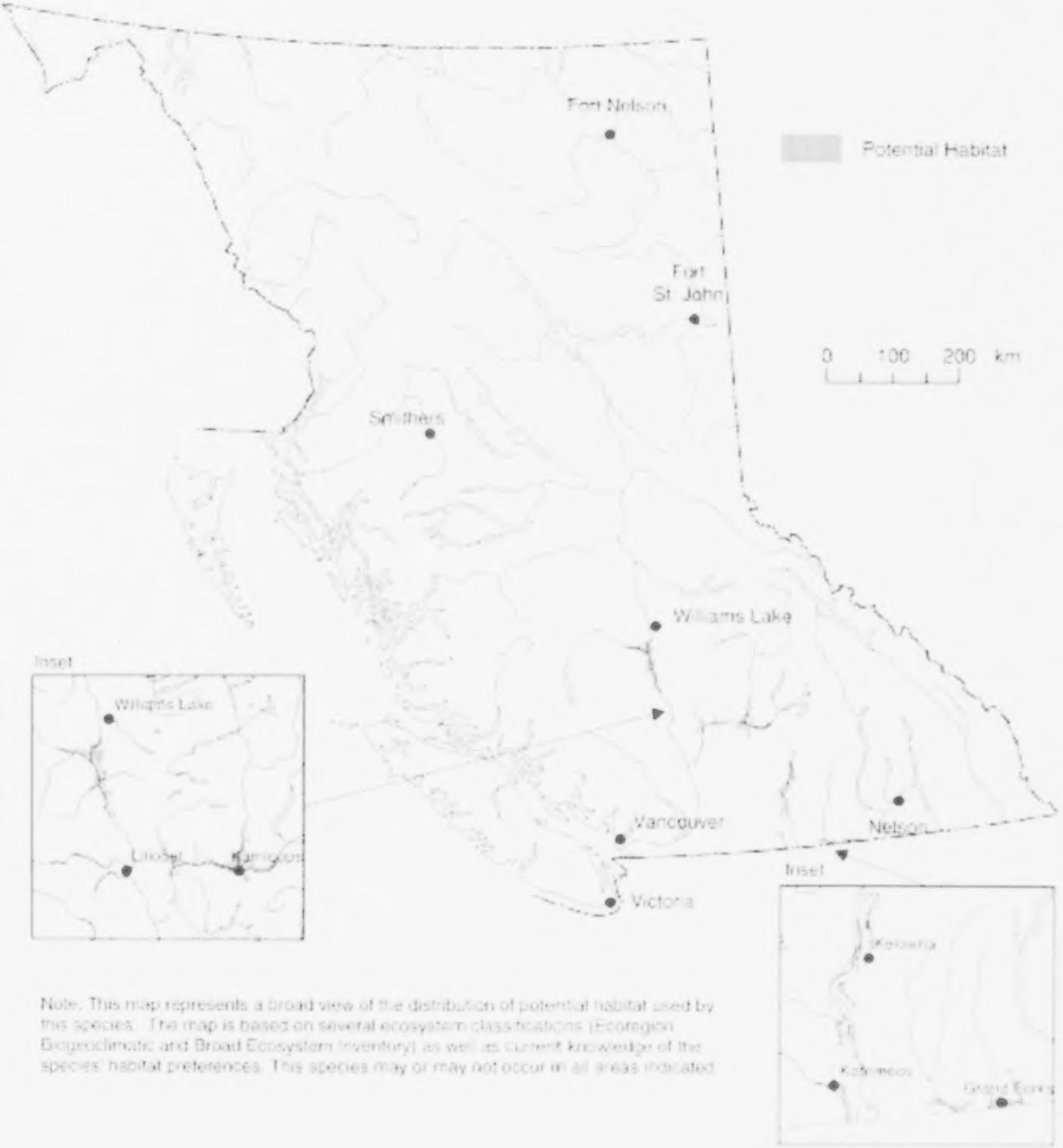
The Yellow-breasted Chat breeds in the extreme southern portions of the province in the Okanagan and Similkameen valleys (Cannings et al. 1987; Campbell et al. 2001). Singing males are occasionally reported from Creston and the Thompson and Fraser River valleys, as far north as the Chilcotin River (Fraser et al. 1999). A possible historic breeding population at Ashcroft has been extirpated (Campbell et al. 2001). Two singing males were recently reported singing in the Pavilion area of British Columbia but evidence of breeding was not confirmed (Cannings 2000). Chats occur irregularly in the lower Fraser Valley with one breeding record at Mission in 1966 (Cannings 2000). Recent unconfirmed reports suggest that a small breeding population has become established near Mission and Chilliwack (MOF and MELP 1998). A singing male was observed at Colony Farm regional park, Coquitlam on 23 June 2001 (C. Bishop, pers. comm.).

---

[1] Volume 1 account prepared by J. Cooper.

Yellow-breasted Chat

(Icteria virens)


Fort Nelson
▨ Potential Habitat
Fort St. John
0 100 200 km
Smithers
Williams Lake
Inset
Williams Lake
Lillooet
Kamloops
Vancouver
Nelson
Victoria
Inset
Kelowna
Keremeos
Grand Forks

Note: This map represents a broad view of the distribution of potential habitat used by this species. The map is based on several ecosystem classifications (Ecoregion, Biogeoclimatic and Broad Ecosystem Inventory) as well as current knowledge of the species' habitat preferences. This species may or may not occur in all areas indicated.

Forest regions and districts

Coast: Chilliwack

Southern Interior: 100 Mile House (possible), Cascades, Central Cariboo, Kamloops, Kootenay Lake, Okanagan Shuswap

Ecoprovinces and ecosections

CEI:	suspected in FRB
GED:	likely in FRL
SIM:	possible in SCM
SOI:	OKR, NOB, SOB, SOH, possible in THB

Biogeoclimatic units

BG:	xh, xw
CWH:	dm
PP:	dh, xh

Broad ecosystem units

BS, CF (hedgerows), CR

Elevation

In British Columbia, the Yellow-breasted Chat occurs from sea level to 70 m elevation on the Coast and between 250 and 800 m elevation in the Interior (Campbell et al. 2001).

Life History

Diet and foraging behaviour

Insects are the primary food source during the breeding season, with berries becoming a more important food source in summer. Young are fed exclusively insects (Ehrlich et al. 1988). Petrides (1938) found that food brought to young in Washington, D.C., consisted primarily of caterpillars. Yellow-breasted Chats forage in the foliage and lower branches of low shrubs and herb layers of thickets (Cannings 1995). Chats are the only warbler species known to hold food with their feet (Aslop 2001).

Reproduction

Dates for 19 clutches in British Columbia ranged from 15 May to 02 July, with 58% recorded between 15 June and 25 June (Campbell et al. 2001). Of nine nests observed by Bishop (pers. comm., 2001) in the south Okanagan in 2001, seven (77%) had clutch dates ranging from 10 June and 20 June, and one clutch was observed on 04 July 2001. Size of 16 clutches ranged from one to four eggs with 88% having three or four eggs (Campbell et al. 2001). Bishop (pers. comm., 2001) found six of nine nests (66%) in the south Okanagan contained clutches of three to four eggs. Clutches of three to four eggs were also most common in an intensive study of chat populations in southern Indiana (Thompson and Nolan 1973).

Incubation period is reported as being 11–12 days (Ehrlich et al. 1988; Aslop 2001). Dates for 12 broods in British Columbia ranged from 29 May to 31 July (Campbell et al. 2001). In the south Okanagan in 2001, dates for eight broods ranged from 07 June to 12 July (C. Bishop, pers. comm., 2001). Sizes of five broods in British Columbia ranged from one to three young (Campbell et al. 2001). The fledgling period is approximately 9 days (Ehrlich et al. 1988), although Bishop (pers. comm., 2001), reported one nest with a fledgling period of 11–12 days. In southern Indiana, Thompson and Nolan (1973) found that 31 of 39 breeding pairs attempted second broods. The spread of clutch initiation dates (i.e., 12 May to 23 June) in the Okanagan Valley (Cannings et al. 1987) suggests that chats may attempt to raise two broods per season in British Columbia as well (Cannings 1995). Bishop (pers. comm., 2001) had concrete evidence of a second brood in one nest in the south Okanagan in 2001, and noted regular singing and flight displays in males following fledging of a first brood.

Yellow-breasted Chats are frequent hosts of Brown-headed Cowbird (*Molothrus ater*) throughout their range (Friedmann 1963, as cited in Campbell et al. 2001). Thirteen percent of 23 nests found in British Columbia (Campbell et al. 2001) and 31% of 42 nests in Missouri were parasitized by cowbirds (Burhans and Thompson 1999). Bishop (pers. comm., 2001) indicated that as many as 55% (5/9) of nests observed in the south Okanagan in 2001 appeared to have been parasitized by cowbirds. Interestingly, young appear to be fledged at a similar rate from parasitized nests as unparasitized nests (Burhans and Thompson 1999), and growth rates do not appear to be reduced in parasitized nests

(Thompson and Nolan 1973). However, two parasitized chat nests in British Columbia were deserted before hatching (Campbell et al. 2001) and Bishop (pers. comm., 2001) found that 40% (2/5) of nests with cowbird presence were depredated early in the nesting cycle.

Site fidelity

Thompson and Nolan (1973) found that no females and only 11% of breeding males returned to their study area in southern Indiana in the years following first capture, suggesting that site fidelity in chats is low. Banding of 22 adult and chick chats in the south Okanagan in 2001 (C. Bishop, pers. comm., 2001) will provide interesting data if banded birds are recaptured in 2002.

Home range

A survey of known chat territories in the south Okanagan in 2000 detected singing male chats in territories estimated to be 0.1–24 ha (Bezener 2001). Bishop (pers. comm., 2001) found that territory size of 25 pairs in the south Okanagan ranged from 0.2 to 5.64 ha, with a mean territory size of 0.99 ha. In southern Indiana, Thompson and Nolan (1973) found that mean territory size ranged between 1.12 and 1.58 ha. Dennis (1958) reported breeding territory sizes of 1.25–2.5 acres in Virginia (i.e., ~0.5–1.0 ha).

Movements and dispersal

Most Yellow-breasted Chats arrive in southern British Columbia in mid-May (Cannings et al. 1987), but some arrive as early as late April (Campbell et al. 2001). No discernible autumn movements have been noted since reports of birds drop sharply once birds stop singing (Campbell et al. 2001). Most birds have likely left the province by early August soon after young have fledged (Cannings et al. 1987).

Habitat

Structural stage

3a: low shrub
3b: high shrub

Important habitats and habitat features

Breeding

Yellow-breasted Chats breed in dense thickets around woodland edges, riparian areas and overgrown clearings or clearcuts (Annand and Thompson 1997; Twedt et al. 1999; Campbell et al. 2001). Populations in British Columbia are associated with riparian habitats, particularly black cottonwood (*Populus balsamifera*) and water birch (*Betula occidentalis*) stands with dense understorey thickets of rose, willow, and common snowberry (*Symphoricarpos albus*). Chats also occupy dense forest-edge thickets where Columbian hawthorn (*Crataegus columbiana*), trembling aspen (*Populus tremuloides*), choke cherry (*Prunus virginiana*), snowberry, and Prairie Rose (*Rosa woodsii*) provide a dense undergrowth (Campbell et al. 2001). Thickets of rose, snowberry, or Himalayan Blackberry (*Rubus discolor*) in uncultivated corners of fields, orchards, and vineyards also provide some habitat (Campbell et al. 2001). Density of shrub cover is apparently more important than species composition of a thicket. Gibbard and Gibbard (1992) found that chats frequented rose thickets ranging in size from 9 to 195 m^2 and an average height of 1.25 m. Trees growing within or close to the thicket generally did not exceed 6 m in height, and large shrubs were usually 3.5 m in height. In the south Okanagan in 2001, Bishop (pers. comm., 2001) found continuous rose patches around nests ranging from ~0.3 to 135 m^2. Chats were generally not found in riparian habitats heavily dissected by cattle trails, in areas with overstorey of large trees, and areas with a high level of traffic noise (Gibbard and Gibbard 1992). Bishop (pers. comm., 2001) found that some territories in the south Okanagan were fragmented by current or recent livestock use and were occasionally close to a busy highway (i.e., #97).

Nests are well concealed in dense shrubbery usually 0.6 to 0.9 m above the ground, are often overgrown with vines, and are under a canopy of cottonwood or water birch (Bent 1953; Bryan et al. 2001; Campbell et al. 2001). The heights of nine nests monitored by Bishop (pers. comm., 2001) in the south Okanagan in 2001 ranged from 0.4 to 1.15 m with the overall average being 0.73 m. The nest is made of coarse leaves, bark, and plant stems, and lined with fine grasses (Godfrey 1986). Most nests in British Columbia were located in rose bushes (Cannings 1995), but snowberry and willow have also been used (Campbell et al. 2001). Burhans and Thompson (1999) found that chats selected larger shrub patches to locate their nests despite increased rates of parasitism. Losses to parasitism were apparently balanced by reduced depredation rates in larger patches. However, Bishop (pers. comm., 2001) found that a number of nests were close to patch edge (range from 0.08 to 10.0 m) with the average being 2.23 m.

Foraging

Yellow-breasted Chats forage within dense riparian breeding habitats during the nesting season. During migration or on their wintering grounds, they can be found in a wide variety of shrubby thickets and densely vegetated riparian areas (Skagen et al. 1998).

Conservation and Management

Status

The Yellow-breasted Chat is on the provincial *Red List* in British Columbia. The British Columbia population of the Yellow-breasted Chat was upgraded from *Threatened* to *Endangered* status in November 2000 (COSEWIC 2002).

Trends

Population trends

Breeding Bird Survey results for 1966 to 1999 (Sauer et al. 2000) indicate no significant changes in U.S. population of Yellow-breasted Chat, but significant increases in Canada (12.7%/yr; $p < 0.01$). Significant declines have been observed in several eastern states including Illinois, Maryland, Ohio, Pennsylvania, Tennessee, West Virginia, and Kentucky. Significant population increases have been documented in Georgia, Mississippi, and North Dakota. An analysis of Breeding Bird Surveys in British Columbia for 1966 to 2000 did not reveal a significant trend (Sauer et al. 2000).

In British Columbia, Cannings (2000) estimated a stable population of 25–30 pairs. Surveys in 2001 located 36 singing males in the Okanagan (highest count to date), 19 occupied territories, and 9 active nests (C. Bishop, pers. comm., 2001). A 1999 survey in the south Okanagan and lower Similkameen valleys in 1999 yielded 19 singing males, compared with the 15 singing males reported by Gibbard and Gibbard (1992). Although results from the various surveys differed substantially, differences are more likely due to variable survey intensity than to changing populations. Cooperation with First Nations in 2001 permitted surveys on Reserve lands, resulting in new location records (C. Bishop, pers. comm., 2001). Taverner (1922) stated that "the [Okanagan] valley is famous for chats…in spite of their apparent scarcity there were enough of them about to seize upon and occupy any specially

Summary of ABI status in BC and adjacent jurisdictions (NatureServe Explorer 2002)

AB	BC	CA	ID	MT	OR	WA	Canada	Global
S3B	S1B	S3	S5B, SZN	S5B, SZN	S4?	S4B, SZN	N4B	G5

desirable locality that might be vacant." Population declines since the early part of the 19th century are largely due to loss of suitable riparian and shrubland habitats due to land development activities (Cannings 1995). Bishop (pers. comm., 2001) suggests that increased livestock use in previously "suitable" Yellow-breasted Chat habitats results in habitat damage through trampling and browsing, and an increase in Brown-headed Cowbird parasitism.

Habitat trends

Breeding habitat in British Columbia is primarily confined to extensive riparian habitats along the Similkameen River south of Keremeos, the old oxbows of the Okanagan River, and Inkaneep Creek on Osoyoos First Nations lands. Habitats associated with the Okanagan River have been heavily impacted in the last 50 years. An estimated 15% of the pre-European quantity of riparian vegetation suitable for chats remains in southern British Columbia (C. Bishop, pers. comm., 2001). Many riparian habitats were severely altered when the Okanagan River was channelized between 1954 and 1958 (Cannings 2000). Flood control effected by channelization permitted landowners to remove riparian habitats and use the land for agriculture. In the last 10 years, incremental loss of riparian habitat has been small; however, a proposed golf course development on the west side of the Okanagan River in Penticton threatens one or two breeding pairs of chats, representing approximately 10% of the B.C. population (Cannings 2000). Surveys of 119 potential sites only found singing males at 14 sites (Gibbard and Gibbard 1992).

Of 5078 ha of habitat considered suitable for chats in the south Okanagan, ownership includes provincial Crown land (6%), Indian Reserve (45%), private land (44%), and conservation lands (5%)(MELP 1998). Participation of "conservation minded landowners, many of whom desire to enhance and rehabilitate areas for chats, represents a critical link in maintaining viable Yellow-breasted Chat habitats.

Threats

Population threats

Pesticide spraying may be a problem in some areas because of the insectivorous feeding habitats of Yellow-breasted Chats (Cadman and Page 1994). Approximately 94% of nest failures reported in a study by Thompson and Nolan (1973) were attributed to predators including snakes, Blue Jay (*Cyanocitta cristata*), and Eastern Chipmunk (*Tamias striatus*). One south Okanagan nest with chicks showed indications of snake "punctures" on dead young (C. Bishop, pers. comm., 2001). In several nests in a study by Thompson and Nolan (1973), egg disappearance closely coincided with deposition of cowbird eggs. Bishop (pers. comm., 2001) found that 40% of five nests in the south Okanagan thought to be parasitized by Brown-headed Cowbirds were depredated early.

Habitat threats

Low elevation riparian habitats are threatened by continuing loss and fragmentation due to agricultural and urban development (Cannings 1995). Any activity that results in the loss or reduction in dense shrubby areas can be detrimental. Livestock grazing, which may result in trampling or damage to riparian thickets, may thus be detrimental (Eckerle and Thompson 2001). Thinning and logging of riparian woodlands is not a significant threat to most chat breeding areas in British Columbia.

Legal Protection and Habitat Conservation

The Yellow-breasted Chat, its nests and eggs are protected in Canada and the United States from hunting and collecting under the *Federal Migratory Birds Act* of 1917. In British Columbia, it is protected under the provincial *Wildlife Act*.

Protected areas in the south Okanagan include the Vaseux Bighorn National Wildlife Area, South Okanagan Wildlife Management Area, and Inkaneep Provincial Park. According to MELP (1998), 5% (i.e., 260 ha) of potentially suitable Yellow-breasted Chat habitat is currently designated as conservation lands in the south Okanagan.

A comprehensive riparian management plan for neotropical migrants is being developed by the Canadian Wildlife Service.

Identified Wildlife Provisions

Sustainable resource management and planning recommendations

Maximize retention and connectivity of riparian habitats and natural grassland communities.

Wildlife habitat area

Goals

Maintain breeding and foraging habitats in areas with aggregations of one or more pairs of Yellow-breasted Chats and selected high suitability historic breeding aggregations.

Feature

Establish WHAs in areas with current breeding concentrations or at historical breeding concentrations in high capability or high suitability habitat.

Size

The size of the WHA will depend on the number of breeding pairs. Between 0.1 and 6 ha of suitable habitat should be secured for each breeding pair. Larger WHAs are more likely to maintain features and conditions for nesting.

Design

The WHAs should include the entire area of thickets that may be used by chats and degraded riparian areas that can be rehabilitated. When fencing of the WHA is being considered, ensure security of chats from predators by providing space between breeding habitat and fence.

General wildlife measures

Goals

1. Maintain or rehabilitate riparian thicket habitat.
2. Ensure livestock do not fragment or trample thicket habitat.
3. Maintain WHA in a properly functioning condition.

Measures

Access

- Do not build new roads and stream crossings unless there is no practicable option.

Pesticides

- Do not use pesticides.

Range

- Provide alternate water, forage, and salt licks for livestock to reduce impacts to wetland and riparian habitats.
- Exclude livestock from riparian or associated riparian habitats within the WHA. If there is no other practicable option to prevent livestock use (i.e., changing timing and intensity of grazing), fencing could be required by the statutory decision maker.

Additional Management Considerations

Rehabilitate riparian habitats damaged by cattle by excluding cattle and revegetating cleared areas with new wild rose thickets and other riparian shrub vegetation (see Bezener 2001). Construct fences between upland areas and riparian habitats to exclude cattle.

Plant wild rose and other shrub species within protected areas, such as Vaseux Lake and Osoyoos Oxbow areas, and inside exclusion fences.

Information Needs

1. Distribution, relative densities, and population trends.
2. Quantification of critical habitat characteristics, particularly those that support breeding chats.
3. Information on usefulness of fencing riparian areas and testing of riparian community response to fencing treatments in riparian corridors of varying widths.

Cross References

Fringed Myotis, "Great Basin" Gopher Snake, Lewis's Woodpecker, Tiger Salamander, water birch–red-osier dogwood

References Cited

Aslop, F.J. III. 2001. Birds of North America, Western Region. Smithsonian Handb. Ser., DK Publishing Inc. New York. 632 p.

Annand, E.M. and F.R. Thompson III. 1997. Forest bird response to regeneration practices in central hardwood forests. J. Wildl. Manage. 61(1):159–171.

Bent, A.C. 1953. Life histories of North American wood warblers. Washington, D.C. U.S. Natl. Mus. Bull. 203.

Bezener, A. 2001. SOSCP Riparian Habitat Stewardship Project: riparian fencing project - literature search summary. Draft report prepared for The Nature Trust of British Columbia and Environ. Can., Can. Wildl. Serv., Delta, B.C.

B.C. Ministry of Environment, Lands and Parks (MELP). 1998. Habitat atlas for wildlife at risk: South Okanagan & Lower Similkameen. Penticton, B.C.

B.C. Ministry of Forests and B.C. Ministry of Environment, Lands and Parks (MOF and MELP). 1998. Species and plant community accounts for Identified Wildlife, Vol. 1. Part of Identified Wildlife management strategies for the Forest Practices Code of British Columbia. Victoria, B.C. 171 p.

Bryan, A., S. Austen, and A. Bezener. 2001. Chats in your neighbourhood. Living in Nature Ser., South Okanagan-Similkameen Stewardship Program.

Burhans, D.E. and F.R. Thompson III. 1999. Habitat patch size and nesting success of Yellow-breasted Chats. Wilson Bull. 111(2):210–215.

Cadman, M.D. and A.M. Page. 1994. Status report on the Yellow-breasted Chat (*Icteria virens*) in Canada. Committee on the Status of Endangered Wildlife in Canada (COSEWIC). Can. Nat. Fed., Ottawa, Ont. 39 p.

Campbell, R.W., N.K. Dawe, I. McTaggart-Cowan, J.M. Cooper, G.W. Kaiser, A.C. Stewart, and M.C.E. McNall. 2001. The birds of British Columbia, Volume 4: Passerines, Wood-warblers through Old World sparrows. B.C. Min. Environ., Lands and Parks, Victoria, B.C., and Can. Wildl. Serv., Delta, B.C.

Cannings, R.J. 1995. Status of the Yellow-breasted Chat in British Columbia. B.C. Min. Environ., Lands and Parks, Wildl. Br., Victoria, B.C. Wildl. Bull. No. B-81.

______. 1998. The birds of British Columbia: a taxonomic catalogue. B.C. Min. Environ., Lands and Parks, Wildl. Br. and Resour. Inv. Br., Victoria, B.C. Wildl. Bull. No. B-86. 243 p.

______. 2000. Update COSEWIC report on Yellow-breasted Chat (*Icteria virens*). Committee on the Status of Endangered Wildl. in Canada, Ottawa, Ont.

Cannings, R.A., R.J. Cannings, and S.G. Cannings. 1987. Birds of the Okanagan Valley, British Columbia. Royal B.C. Mus., Victoria, B.C.

Committee on the Status of Endangered Wildlife in Canada (COSEWIC). 2002. Canadian species at risk. Available from: http://www.speciesatrisk.gc.ca

Dennis, J.V. 1958. Some aspects of the breeding ecology of the Yellow-breasted Chat (*Icteria virens*). Bird-Banding 29:169–183.

Eckerle, K.P. and C.F. Thompson. 2001. Yellow-breasted Chat (*Icteria virens*). *In* The birds of North America, No. 575. A. Poole and F. Gill (editors). The Birds of North America, Inc., Philadelphia, Penn.

Ehrlich, P.R., D.S. Dobkin, and D. Wheye. 1988. The birder's handbook: a field guide to the natural history of North American birds. Simon & Schuster Inc., Toronto, Ont.

Fraser, D.F., W.L. Harper, S.G. Cannings, and J.M. Cooper. 1999. Rare birds of British Columbia. B.C. Min. Environ., Lands and Parks, Wildl. Br. and Resour. Inv. Br., Victoria, B.C. 244 p.

Friedmann, H. 1963. Host relations of the parasitic cowbirds. Washington, D.C. U.S. Natl. Mus. Bull. 233. 276 p.

Gibbard, R.T. and M. Gibbard. 1992. Field survey of the Yellow-breasted Chat in the south Okanagan. Report for B.C. Min. Environ., Lands and Parks, Penticton, B.C. 14 p. Unpubl.

Godfrey, W.E. 1986 The birds of Canada. 2nd ed. Natl. Mus. Can., Ottawa, Ont.

Howell, S.N.G. and S. Webb. 1995. A guide to the birds of Mexico and northern Central America. Oxford Univ. Press, New York, N.Y.

National Geographic Society (NGS). 1999. Field guide to birds of North America. Washington, D.C.

NatureServe Explorer. 2002. An online encyclopedia of life [Web application]. Version 1.6. Arlington, Va. Available from: http://www.natureserve.org/explorer

Petrides, G.A. 1938. A life history study of the Yellow-breasted Chat. Wilson Bull. 50:184–189.

Sauer, J.R., J.E. Hines, I. Thomas, J. Fallon, and G. Gough. 2000. *The North American Breeding Bird Survey, results and analysis 1966–1999.* Version 98.1. U.S. Geol. Surv., Patuxent Wildl. Res. Cent., Laurel, Md.

Sibley, C.G. 1996. Birds of the world, version 2.0. *In* Birder's Diary V2.5, Thayer Birding Software.

Skagen, S.K., C.P. Melcher, W.H. Howe, and F.L. Knopf. 1998. Comparative use of riparian corridors and oases by migrating birds in southeast Arizona. Conserv. Biol. 12:896–909.

Taverner, P.A 1922. Notes on the birds of the Okanagan Valley. Natl. Mus. Nat. Sci., Ottawa, Ont. Unpubl. field notes

Thompson, C.F. and V. Nolan, Jr. 1973. Population biology of the Yellow-breasted Chat (*Icteria virens* L.) in southern Indiana. Ecol. Monogr. 43:145–171.

Twedt, D.J., R.R. Wilson, J.L. Henne-Kerr, and R.B. Hamilton. 1999. Impact of forest type and management strategy on avian densities in the Mississippi Alluvial Valley, USA. For. Ecol. Manage. 123:261–274.

Personal Communications

Bishop, C. 2001. Canadian Wildlife Service. Delta, B.C.

BADGER

Taxidea taxus jeffersonii

Original[1] prepared by Ian T. Adams
and Trevor A. Kinley

Species Information

Taxonomy

Of the seven species of badgers, only the "American" Badger, *Taxidea taxus* (Schreber), occurs in North America. The subspecific classification accepted by COSEWIC and the CDC follows that proposed by Long (1972) and accepted with no or few modifications by Banfield (1974), Hall (1981), Long and Killingley (1983), and Messick (1987). Based on skull morphology, pelage colour, and range, the four subspecies are *T. taxus berlandieri*, *T. taxus jacksoni*, *T. taxus jeffersonii*, and *T. taxus taxus*. Only *T. taxus jeffersonii* occurs in British Columbia.

Description

The most distinctive features of the Badger is its posture and head colouration. It is a squat carnivore weighing 6–12 kg, with dense, coarse hair reaching nearly to the ground, typically giving the impression of an animal with very short legs. The head is characterized by alternating black and white bands, including a white dorsal stripe, black immediately anterior to the eyes, white immediately posterior to the eyes, black on the cheeks, and white immediately anterior to the ears. Other aids to field identification include dark brown to black legs; mottled body hair of mixed white, black, grey, and brown; extremely long claws (front claws often in excess of 5 cm); and rapid burrowing when disturbed or in pursuit of food. The *jeffersonii* subspecies is distinguished by its range (below), reddish brown colouration, large size, and short dorsal stripe. See Long and Killingley (1983) for a detailed morphological description, including subspecific characteristics.

Distribution

Global

The American Badger occurs only in central and western North America, from southern Canada to northern Mexico. Hall (1981) indicates the *jeffersonii* subspecies to occur from the Rockies westward as far north as southern British Columbia and as far south as the southern parts of Colorado, Utah, Nevada, and California.

British Columbia

Badgers occur within the drier parts of the Kootenays, southern interior, and central interior. The southern boundary follows the U.S. border from Alberta to the Similkameen River headwaters. The approximate western limit is the Cascade Mountains and middle section of the Fraser River (except in the lower Chilcotin drainage). The northern limit approximates a line from Alexis Creek to Quesnel Lake. The eastern boundary follows the west edge of the Cariboo and Monashee mountains to Lower Arrow Lake, then east across the Selkirk Mountains to Kootenay Lake, then north through the Purcell Mountains, Rocky Mountain Trench and Rocky Mountains to the Trans-Canada Highway, then east to the Alberta boundary and southeast along the provincial border.

Forest regions and districts

Southern Interior: 100 Mile House, Arrow Boundary, Cascades, Central Cariboo, Chilcotin (extreme east-central only), Columbia (southeast only), Headwaters (south only), Kamloops, Kootenay Lake (south only), Okanagan Shuswap, Quesnel (extreme south-central only), Rocky Mountain

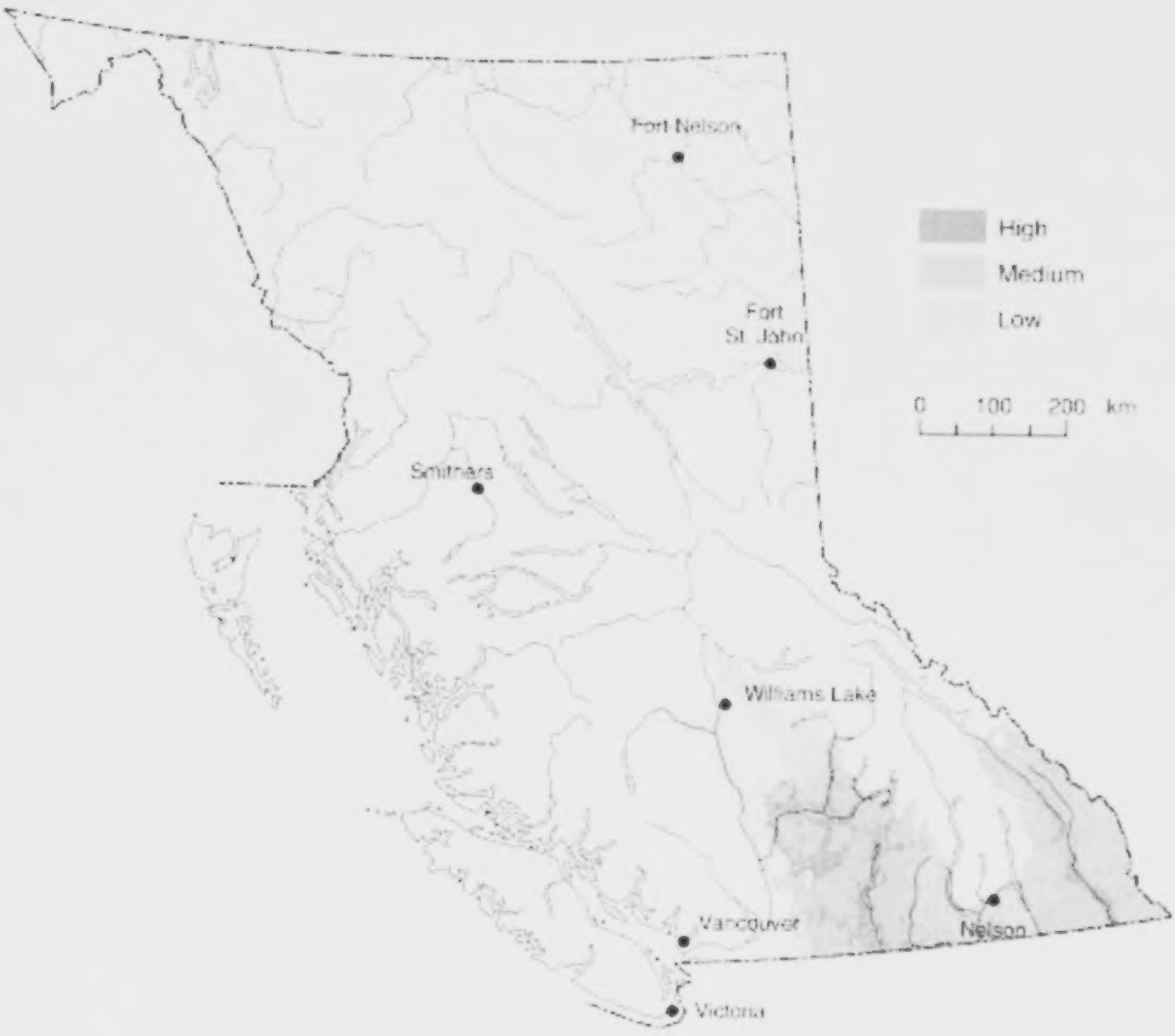
Coast: Chilliwack (extreme east only)

---

[1] Draft account for Volume 1 prepared by L. Gyug.

Badger

(Taxidea taxus)


Fort Nelson
Fort St. John
Smithers
Williams Lake
Vancouver
Nelson
Victoria
High
Medium
Low
0
100
200
km

Note: This map represents a broad view of the distribution of potential habitat used by this species. The map is based on several ecosystem classifications (Ecoregion, Biogeoclimatic and Broad Ecosystem Inventory) as well as current knowledge of the species' habitat preferences. This species may or may not occur in all areas indicated.

Ecoprovinces and ecosections

CEI: CAB, CAP, CHP (lowest elevations only), FRB

SIM: COC, EKT, EPM, FLV, MCR, SCM, SFH, SHH (extreme south only), SPK

SOI: HOR, NOB, NOH, NTU, OKR, PAR, SOB, SOH, STU, THB

Biogeoclimatic units

AT

BG: xh1, xh2, xh3, xw, xw1, xw2

ESSF: dc1, dc2, dcp, dk, dkp, mw, mwp, wc1, wc4, wcp, wm, wmp, xc, xcp

ICH: dw, mk1, mk2, mk3, mw1, mw2, mw3, xw

IDF: dk1, dk2, dk3, dm1, dm2, mw, mw1, mw2, un, xh1, xh2, xm, xw, xw2

MS: dk, dm1, dm2, un, xk

PP: dh1, dh2, xh1, xh2

SBPS: mk

SBS: dw1, dw2, mc1, mm, un

Broad ecosystem units

Southern Interior Forest: AC, DF, DL, DP, EF, IG, IH, IS, PP, RB, RD, SD

Central and Northern Forest: LP, SF, SL

Subalpine Parkland and Krummholz: FP, WB

Shrub and Herb Dominated: AB, BS, MS, SS

Non-forested Subalpine and Alpine: AG, AM, AT, SG, SM

Sparsely Vegetated: UV

Urban and Agricultural: CF, MI, OV, RM, TC, TR, UR

Elevation

Badger occurrence is usually greatest near valley bottoms but at least some populations make regular use of all elevations, including the alpine. Minimum elevations are 300–800 m, depending on the region, while the maximum elevation is about 2800 m.

Life History

Diet and foraging behaviour

Badgers are adapted to capturing fossorial prey, which is their primary diet in most locations (Lampe 1982; Salt 1976). However, badgers supplement their diet with a wide variety of mammals, birds, eggs, reptiles, amphibians, invertebrates, and plants (Messick 1987). Fecal and stomach samples have included Columbian Ground Squirrels, Yellow-bellied Marmots, Northern Pocket Gophers, Red-backed Voles, Deer Mice, Great-Basin Pocket Gopher, ungulates, insects, sparrows, Common Loon, leporid, sucker, salmonid, Yellow-Bellied Racer, Western Rattlesnake, Long-Toed Salamander, frog or toad, and unidentified remains (Newhouse and Kinley 2002; H. Davis, Artemis Wildlife Consultants, unpubl. data; C. Hoodicoff, Univ. Victoria, unpubl. data; D. Nagorsen, formerly Royal B.C. Mus., pers. comm.; N. Newhouse, Sylvan Consulting Ltd., unpubl. data).

Dens function as sites for resting, food storage, and parturition, and as central nodes from which foraging is based. In Utah, Lindzey (1978) found that only 15% of all dens used by badgers were dug immediately before their use and some dens were reused numerous times by the same badger. Newhouse (1999) noted that 60% of radio-locations were in reused burrows, and also documented different badgers using the same burrow at different times. Maternal dens differ from those used for diurnal resting in that they are more structurally complex with larger soil mounds at the entrance (Lindzey 1976). A high degree of individual and interannual variation in winter torpor has also been noted, with some individuals active throughout most of the winter and others remaining in one burrow for up to 98 days (Newhouse 1997).

Reproduction

Badgers are promiscuous, with breeding occurring in late July and August (Messick and Hornocker 1981). Implantation is delayed until February, with parturition occurring in late March or early April. Litter sizes range from one to five kits (Lindzey 1982). Litter sizes among radio-tagged females in the East Kootenay and Thompson-Okanagan have varied from zero to three, recorded 6–10 weeks post-partum, although members of the public have reported local litters of up to four (Newhouse and Kinley 2002; Weir and Hoodicoff 2002; N. Newhouse, Sylvan Consulting Ltd., unpubl. data).

Home range and movement

As of 2000, mean home ranges in the East Kootenay were 51 km^2 for females and 450 km^2 for males, based on the minimum convex polygon (MCP) method. Another subsample of badgers recently radio-tagged at the southern end of the East Kootenay appears to have considerably smaller ranges, but data are not yet complete. Mean home ranges in the Thompson-Okanagan region are similar to those in the East Kootenay (Weir and Hoodicoff 2002). Home ranges in British Columbia are much larger than those found in Idaho, Wyoming, and Illinois (2–44 km^2 based on MCP; Messick and Hornocker 1981; Minta 1993; Warner and Ver Steeg 1995).

Juvenile dispersal generally occurs in June through August, but cases of dispersal not occurring until the age of 1 year have been recorded (N. Newhouse, unpubl. data).

Habitat

Structural stage

For forested habitat types in which older structural stages are characterized by closed-canopy forest, structural stage is critical. In such cases, prey abundance can sometimes be very high in structural stages 0 and 1, but typically diminishes rapidly after that.

For open-canopied and non-forested habitat types, the importance of grassland structural stages varies according to local prey base. In areas where Columbian Ground Squirrels are present, vegetative structure may play a relatively insignificant role. However, where ground squirrels are not present, badgers are more reliant on microtine rodents (mice and voles). At these sites, mid- to late-seral, highly structured grasslands are important habitat features for badger prey.

Important habitats and habitat features

In British Columbia most badger activity is at low elevations in dry regions (BG, PP, IDF) within native or non-native grasslands, open forests of Douglas-fir or ponderosa pine, and disturbed sites such as roadsides and agricultural fields. However, badgers have also been documented using cutblocks, burns, early-seral forests of several species composition, other open sites in the ICH, MS, ESSF biogeoclimatic zones and parts of the SBPS and SBS and occasionally the AT (Apps et al. 2002; Weir and Hoodicoff 2002). Newhouse and Kinley (2000) documented individual male badgers regularly travelling between the IDF and the AT biogeoclimatic zones. Badgers are also adaptable by region and by season to a wide variety of food sources. Badgers appear to be relatively tolerant of human presence, as evidenced by their use of golf courses, abandoned buildings, and roadsides (Newhouse 1999), although there are presumably upper limits to the level of habitat alteration, number of movement barriers, or amount of direct human disturbance that badgers will tolerate.

Burrowing and foraging

Badger burrow and hunting sites are typically within sites dominated by grass, forbs, or low shrubs, either in non-forest, open forest, or very young forest. Badgers are typically found in or near colonies of prey species, such as Columbian Ground Squirrels or Yellow-Bellied Marmots. Ground squirrels appear to slightly favour sites with a preponderance of forbs relative to grass and shrubs. However, without these species, badgers may rely on more evenly dispersed microtine rodents.

A variety of soil types are used, but the most common types are moderately coarse-textured Brunisols with low to moderate (<35%) coarse fragment content, originating from glaciofluvial and glaciolacustrine parent material. Where available, Chernozems are probably also selected. Badgers that occur in areas with predominantly morainal deposits (e.g., ESSF, MS forests) may be limited to using disturbed soils (e.g., overburden, road fill) or small areas with glaciofluvial deposits in these areas. Although badgers sometimes burrow along disturbed road rights-of-way, the high mortality risk associated with such locations probably outweighs any habitat value there. Distance from other mortality or harassment risks such as dogs are another important habitat feature. Because badgers maintain and use several burrows over a large home range, identifying a burrow as "active" or "inactive" is difficult. Burrows are readily reused by both badgers and other species (e.g., Burrowing Owl).

Conservation and Management

Status

The Badger is on the provincial *Red List* in British Columbia. In Canada, it is listed as *Endangered* (COSEWIC 2002). (See Summary of ABI status in BC and adjacent jurisdictions at bottom of page.)

Trends

Population trends

The most recent estimate for badger numbers in the province is <200 breeding adults (Adams et al. 2002). This is considerably lower than an earlier estimate of 300–1000 (Rahme et al. 1995). It is not clear whether this difference is due to recent population declines or simply a lack of information with which to make the earlier estimate. Pelt records do indicate a much larger population historically, with 200–350 pelts reported annually from British Columbia in 5 years within the 1920s, and this presumably represents only a portion of the total kill (Adams et al. 2002). In addition, there are examples of badgers disappearing (or nearly so) from relatively large areas in the recent past, such as the apparent near extirpation of badgers from the upper Columbia Valley in the past decade. However, even within areas of relatively healthy badger populations, numbers likely oscillate somewhat with changes in prey densities. Thus, the medium- to long-term trend in badger numbers has been downward, with the short-term trend unknown.

In southeast British Columbia, the average annual mortality was 23% among adults and 45% among juveniles (<1 yr), with causes of mortality among study animals including roadkill, probable predation by cougar, train kill, old age, predation by bobcat, and unknown. Trapping and shooting also resulted in the death of untagged animals (Newhouse and Kinley 2002).

Habitat trends

Throughout the regions of British Columbia that were historically dominated by grassland, shrub-steppe, and open forest, habitat has been lost over the past century due to forest encroachment and in-growth (as defined by Kirby and Campbell 1999). In some places, the pace of such losses may have slowed somewhat in recent years with the initiation of habitat restoration burns. Within more densely forested areas, some habitat has been created temporarily through logging (particularly where new forests have been slow to regrow). However, in areas with moderate to short historic fire-return intervals, gains from forest harvesting have probably been outpaced by the prevention of forest fires and the replanting of trees after burns. Post-harvesting habitat is generally short lived due to current stocking densities and "free-to-grow" requirements. Habitat has also been lost to human settlement, highways, intensive agriculture, gravel/sand pits, hydroelectric reservoirs, and the elimination of ground squirrel colonies. Thus, both the short- and long-term trends in habitat have been downward.

Summary of ABI status in BC and adjacent jurisdictions (NatureServe Explorer 2002)

AB	BC	CA	ID	MT	OR	WA	Canada	Global
S4	S1	S4	S5	S4	S4	S5[a]	N4	G5[b]

[a] Badgers will soon be under review in Washington where wildlife managers have significant concerns over its status, especially close to the British Columbia border (H. Allen, pers. comm.).

[b] There is no global ranking for the Taxidea taxus jeffersonii subspecies. This rank reflects the global rank for the entire Taxidea taxus species.

Threats

Several threats exist to badgers and their habitat (Table 1). Some of these are historical and likely led to the initial decline in badger numbers across the province but have since been at least partially abated. Other threats continue or are increasing.

Population threats

A large proportion of known death of instrumented badgers results from highway mortality. Their vulnerability to roadkill is due to several factors:

- Badgers prefer open valley bottom habitats, where highways are most often constructed.
- Large home ranges (especially males) may increase the frequency of encounters with highways.
- Disturbed soils adjacent to highways are ideal digging substrates for both badgers and their prey.
- Prey densities may be higher near highways because rights-of-way are maintained in early successional, grassy stages.
- Badgers' fearless behaviour, typical of most mustelids, leaves them vulnerable to road kills.
- Badgers are most active at night, when drivers will have the most difficulty seeing a relatively small, low-to-the-ground animal.
- Badgers may use roadside ditches and right-of-ways as extensive linear movement corridors.

Extermination of prey species such as ground squirrels, marmots, and pocket gophers may reduce food available to badgers. Secondary effects from consuming poisoned prey may also have harmful results on badgers. Habitat degradation due to poor range practices has also likely led to reductions in prey species with subsequent effects on badger population levels.

Badgers are killed by landowners who either directly fear them or consider them nuisance animals whose diggings may damage machinery or pose a threat to livestock.

The observed low reproductive output in British Columbia may inhibit badgers' ability to recover from lowered population levels. Banci and Proulx

Table 1. List of probable continuing and historic threats to badger populations and habitat in British Columbia ranked by relative impact (predominant or contributing), spatial distribution of the threat (widespread or local), temporal impacts (chronic, episodic, or ephemeral), and degree to which the threat has been reduced. (Source: Adams et al. 2002).

Threat	Impact	Spatial	Temporal	Continuing
Trapping	predominant	widespread	episodic	yes
Persecution	contributing[a]	widespread	chronic	partially
Urban development	predominant	widespread	episodic	increasing
Cultivation	contributing	widespread	chronic	no
Viniculture & orchards	contributing	local	chronic	no
Forest in-growth & encroachment	contributing	widespread	chronic	partially
Reservoir flooding	contributing[b]	local	chronic	no
Highway mortality	predominant	widespread	chronic	increasing
Extermination of prey	contributing	widespread	episodic	no
Secondary poisoning via prey	contributing	local	ephemeral	partially

[a] Degree of persecution is unknown. Impact is potentially substantial at a local level.

[b] Across all of British Columbia, reservoir flooding has likely had limited impact on population numbers. However at a local level (e.g., Lake Koocanusa in southern Rocky Mountain Trench), impacts are likely predominant.

(1999) classified the badger as a low resiliency species in British Columbia (i.e., with a low capability to recover from a reduction in numbers). They attribute the low resiliency to the fact that badger populations have a relatively low reproductive rate, extensive dispersal movements, and high human-caused mortality other than trapping. Human-caused mortality should be kept to a minimum (i.e., <10%) (Banci and Proulx 1999).

Habitat threats

There are several threats to badger habitat, including:

- highway construction
- urban development
- cultivation agriculture
- viniculture and orchard development
- forest in-growth and encroachment
- gravel and sand pits
- reservoir flooding
- poor range practices
- unfettered motorized access to grassland and open-forest ecosystems

Many of these threats present semi-permeable barriers to badgers. They readily cross highways; are known to swim across reservoirs; and will use cultivated fields, orchards, and ginseng farms. However, all of these represent varying degrees of habitat degradation, often as a result of reduced prey availability and increased mortality risk.

An important aspect regarding badger habitat loss is that impacts are exacerbated by negative human attitudes toward badgers. Badgers have been sighted at golf courses, ginseng farms, mine sites, ski hills; and within urban areas. However, humans tend to be intolerant (sometimes fearful) of badgers and either exterminate them directly or remove their prey.

Legal Protection and Habitat Conservation

Badgers have been protected from trapping and hunting under the provincial *Wildlife Act*. However, under Section 26 of the *Wildlife Act*, any species not listed as threatened or endangered and deemed to be a menace to domestic animals or birds may be killed by the property owner. Although red-listed by the B.C. Conservation Data Centre, badgers are not formally listed as threatened or endangered under the *Wildlife Act*.

Most prey species, including Columbian Ground Squirrel, Yellow-bellied Marmot, Northern Pocket Gopher, *Peromyscus* spp., and arvicolid rodents (voles) are protected on Crown land. However all are listed under Schedule B of the designation and exemption regulations of the *Wildlife Act* and may be legally killed on private land to protect property.

Protected areas currently provide little conservation value. In the East Kootenay region, protected areas represent 15% of the area available, but only 3% of probable badger habitat (Apps et al. 2002). Conversely, private lands represent 9% of the study area, but 35% of probable habitat (Apps et al. 2002). Despite new protected areas in the Okanagan region, a similar situation exists there. Further, badger home ranges are larger than most protected areas with probable badger habitat.

Large protected areas with suitable badger habitat include Kootenay National Park, Kikomun Creek Provincial Park, Lac du Bois Grasslands Provincial Park, Okanagan Mountain Provincial Park, White Lake Grasslands Provincial Park, and South Okanagan Grasslands Provincial Park. Outside of these parks, no significant habitat conservation actions have been taken specifically for badgers although badgers have been identified as part of the rationale for acquisition of conservation lands by non-profit organizations, and for restoring habitat within landscapes historically dominated by open habitats.

A functioning *jeffersonii* badger Recovery Team is in place under provincial jurisdiction with the B.C. Ministry of Water, Land and Air Protection as the lead agency. A draft recovery strategy (Adams et al. 2002) is under review and actions toward increasing badger populations in British Columbia are under way.

The Wildlife Habitat Feature designation under the results based code may be sufficient to protect and maintain badger burrows, especially maternal dens, provided that a 20-m radius (or one tree length, whichever is less) around the burrow is kept free of machinery impacts and soil disturbance. Characteristics or evidence of a maternal den include larger than average burrow (lots of dirt and signs of repeated use such as tracks, fresh digging), repeated sightings of adult badger within a small area, sighting of badger kits, and documented historic use. Burrows may also be protected on cutblocks using wildlife tree retention areas.

Livestock grazing practices on Crown rangelands should adhere to prescribed range use plans as administered by the Ministry of Forests under the results based code.

Identified Wildlife Provisions

Sustainable resources management and planning recommendations

The highest quality badger habitats occur in Natural Disturbance Type 4 (NDT4). Sites are characterized by:

- frequent, stand-maintaining fires
- generally open grassland or sparsely treed areas
- high densities of prey populations
- Brunisol and Chernozem soil types with fine sandy loam structure (generally friable soils without large rocks).

The focus of the following recommendations and measures are based on management in these areas. However, badgers in British Columbia are known to use NDT3 sites that have not been restocked, often following logging operations or severe fires. These NDT3 sites may represent a significant portion of the provincial badger population but are much more difficult to manage under current fire suppression, restocking, and Free-to-Grow requirements.

- ❖ Maintain areas of high habitat value for badgers.
- ❖ Maximize connectivity between areas of higher habitat value by minimizing urbanization and conversion of agricultural land to residential, industrial, or other developments.
- ❖ Maintain seral stage and structure on all habitats to support prey base.
- ❖ Maintain lowest possible road densities.
- ❖ Continue/increase restoration activities that reduce forest in-growth and encroachment.
- ❖ Reduce re-stocking rates in NDT4 zones (no planting wherever possible).
- ❖ Create and maintain a range of successional and structural stages of grassland and open forest ecosystems with structure and cover attractive to ground squirrels and other prey species.
- ❖ Leave larger, older trees to provide more ecological stability.

Wildlife habitat area

Goal

Protect critical habitat such as concentrations of burrow sites, especially maternal dens, and concentrations of prey species or friable soil habitat.

Feature

Establish WHAs in areas identified as critical badger habitat (e.g., concentration of burrows, abundant prey sources, and localized preferred friable soil types including moderately coarse-textured Brunisols originating from glaciofluvial and glaciolacustrine parent material) by the Regional Recovery Action Groups established by the National Recovery Team.

Size

Generally 2–100 ha, depending on site characteristics such as badger population density, soil types, number of burrows, and frequency of use.

Design

Design WHAs to include known burrows and/or prey concentrations and areas of suitable habitat. Use soil or geologic boundaries wherever possible.

General wildlife measures

Goals

1. Maintain important habitat features including sufficient structure/litter to provide hiding cover, open- or non-forested land, grasslands in a range of seral stages, friable soils, and prey.

2. Control forest encroachment and in-growth.
3. Manage livestock grazing to maintain suitable habitat for prey species (Columbian Ground Squirrel, Yellow-bellied Marmot, microtine rodents).
4. Minimize disturbance during the breeding season.

Measures

Access

- Do not develop any new road access.
- Restrict access to active maternal areas between 1 May and 15 August. Active areas may be identified by observed sightings of family groups (>1 badger) or other means (e.g., radio-telemetry). Active closures need only be in place for the current season.
- Close all established roads after resource extraction is completed.

Harvesting and silviculture

- Harvest as required to support ecological restoration. Reduce stocking densities (<75 stems/ha; target of 20 stems/ha) and free-to-grow requirements.
- Leave a selection of live and dead trees to maintain site ecology.

Pesticides

- Do not use pesticides.

Range

- Do not place livestock attractants in WHA.
- Manage livestock grazing to ensure proper conditions (seral and structural stages) for prey species. Conditions will vary depending on the prey species present.

Additional Management Considerations

Where appropriate, apply restoration treatments to maintain/create grassland and open forest conditions suitable as badger habitat.

Where feasible, maintain disturbed, early seral NDT3 sites as badger habitat by delaying and/or reducing restocking.

Encourage private land stewardship.

Protect prey species. Do not use rodenticides.

Off-road vehicle use (e.g., ATVs) should be restricted in areas of high badger use.

Information Needs

1. Predator–prey interactions including ecological requirements of various prey species, importance of Columbian Ground Squirrels as prey; implications of range/forest management strategies on prey species.
2. Distribution and abundance of badgers beyond Thompson and East Kootenay regions.
3. Contribution of NDT3 and alpine sites to provincial badger population, habitat supply, and connectivity.

Cross References

Bighorn Sheep, Burrowing Owl, "Columbian" Sharp-tailed Grouse, Grasshopper Sparrow, Long-billed Curlew, Racer, Sage Thrasher, "Sagebrush" Brewer's Sparrow, Sonora Skipper, Sooty Hairstreak, Western Rattlesnake, White-headed Woodpecker

antelope-brush–bluebunch wheatgrass, Douglas-fir–snowberry–balsamroot, ponderosa pine–bluebunch wheatgrass–silky lupine

References Cited

Adams, I., T. Antifeau, M. Badry, L. Campbell, A. Dibb, O. Dyer, W. Erickson, C. Hoodicoff, L. Ingham, A. Jackson, K. Larsen, T. Munson, N. Newhouse, B. Persello, J. Surgenor, K. Sutherland, J. Steciw, and R. Weir. 2002. Draft national recovery strategy for American Badger, *jeffersonii* subspecies, (*Taxidea taxus jeffersonii*). Recovery of Nationally Endangered Wildl., Ottawa, Ont.

Apps, C.D., N.J. Newhouse, and T.A. Kinley. 2002. Habitat associations of American badgers in southeastern British Columbia. Can. J. Zool. 80:1228–1239.

Banci, V. and G. Proulx. 1999. Resiliency of furbearers to trapping in Canada. *In* Mammal trapping. G. Proulx (editor). Alpha Wildl. Res. and Manage. Ltd., Sherwood Park, Alta., pp. 175–203.

Banfield, A.W.F. 1974. The mammals of Canada. Univ. Toronto Press, Toronto, Ont.

Committee on the Status of Endangered Wildlife in Canada (COSEWIC). 2002. Canadian species at risk. Available from: http://www.speciesatrisk.gc.ca

Hall, E.R. 1981. The mammals of North America. John Wiley & Sons, New York, N.Y.

Kirby, J. and D. Campbell. 1999. Forest in-growth and encroachment: a provincial overview from a range management perspective. Report prepared for B.C. Min. For., For. Practices Br., Victoria, B.C. Unpubl.

Lampe, R. 1982. Food habits of badgers in east central Minnesota. J. Wildl. Manage. 46:790–795.

Lindzey, F.G. 1976. Characteristics of the natal den of the badger. Northwest Sci. 50:178–180.

______. 1978. Movement patterns of badgers in northwestern Utah. J. Wildl. Manage. 42:418–422.

______. 1982. The North American badger. *In* Wild mammals of North America: biology, management and economics. J.A. Chapman and G.A. Feldhammer (editors). Johns Hopkins Univ. Press, Baltimore, Md., pp. 653–663.

Long, C.A. 1972. Taxonomic revision of the North American badger, *Taxidea taxus*. J. Mammal. 53:725–759.

Long, C.A. and C.A. Killingley. 1983. The badgers of the world. Charles C. Thomas, Springfield, Ill.

Messick, J.P. 1987. North American badger. *In* Wild furbearer management and conservation in North America. M. Novak, J.A. Baker, M.E. Obbard, and B. Malloch (editors). Ont. Min. Nat. Resour., Toronto, Ont., pp. 587–597.

Messick, J.P. and M.G. Hornocker. 1981. Ecology of badgers in southwestern Idaho. Wildl. Monogr. 76.

Minta, S.C. 1993. Sexual differences in spatio-temporal interaction among badgers. Oecologia 96:402–409.

NatureServe Explorer. 2002. An online encyclopedia of life [Web application]. Version 1.6. Arlington, Va. Available from: http://www.natureserve.org/explorer

Newhouse, N. 1997. East Kootenay badger project 1996/97 year-end summary report. Forest Renewal BC, Cranbrook, B.C., Columbia Basin Fish and Wildl. Compensation Program, Nelson, B.C., and Kootenay National Park, Radium Hot Springs, B.C.

______. 1999. East Kootenay badger project 1998/99 year-end summary report. East Kootenay Environ. Soc., Kimberley, B.C., Forest Renewal BC, Cranbrook, B.C., Columbia Basin Fish and Wildl. Compensation Program, Nelson, B.C., and Can. Parks Serv., Radium Hot Springs, B.C.

Newhouse, N.J. and T.A. Kinley. 2000. Ecology of American badgers near their range limit in southeastern British Columbia. Columbia Basin Fish and Wildl. Compensation Program, Nelson, B.C., Crestbrook Forest Industries, Cranbrook, B.C., East Kootenay Environ. Soc., Kimberley, B.C., and Parks Canada, Radium Hot Springs, B.C.

______. 2002. Badgers: can we dig them out of this hole? An update on population ecology and conservation of badgers in southeast British Columbia. Research Links Parks Canada newsletter.

Rahme, A.H., A.S. Harestad, and F.L. Bunnell. 1995. Status of the badger in British Columbia. B.C. Min. Environ., Lands and Parks, Victoria, B.C. Wildl. Work. Rep. WR-72.

Salt, J.R. 1976. Seasonal food and prey relationships of badgers in east-central Alberta. Blue Jay 34:119–123.

Warner, R.E. and B. Ver Steeg. 1995. Illinois badger studies. Ill. Dep. Nat. Resour., Springfield, Ill.

Weir, R.D. and C. Hoodicoff. 2002. Development of conservation strategies for badgers in the Thompson & Okanagan regions. 2001-02 annual report. Artemis Wildl. Consultants, Armstrong, B.C.

Personal Communications

Allen, H. 2002. Washington Dep. Natural Resources. Olympia, Wash.

Nagorsen, D. 2002. formerly Royal B.C. Museum, Victoria, B.C.

CARIBOU

Rangifer tarandus

Original prepared by Deborah Cichowski,
Trevor Kinley, and Brian Churchill

Species Information

Taxonomy

Rangifer tarandus includes seven extant subspecies: Reindeer (*R. tarandus tarandus*), Wild Forest Reindeer (*R. tarandus fennicus*), and Svalbard Reindeer (*R. tarandus platyrhynchus*) in Eurasia; and Barren-ground Caribou (*R. tarandus groenlandicus*), Alaskan Caribou (*R. tarandus granti*), Peary Caribou (*R. tarandus pearyi*), and Woodland Caribou (*R. tarandus caribou*) in North America.

The Woodland Caribou includes several ecotypes, which have no formal taxonomic designation but are defined on the basis of distinct patterns of habitat use and diet/feeding behaviour. The three ecotypes described in this account are known as Mountain Caribou, Northern Caribou, and Boreal Caribou (Heard and Vagt 1998) and can be distinguished from each other by the combination of three interrelated features (Table 1).

Description

Woodland Caribou are a large, dark subspecies with short, heavy antlers (Banfield 1961) occurring in parts of boreal, cordilleran, and southeastern arctic Canada. There has been no scientific description specific to the three caribou ecotypes in British Columbia.

Distribution

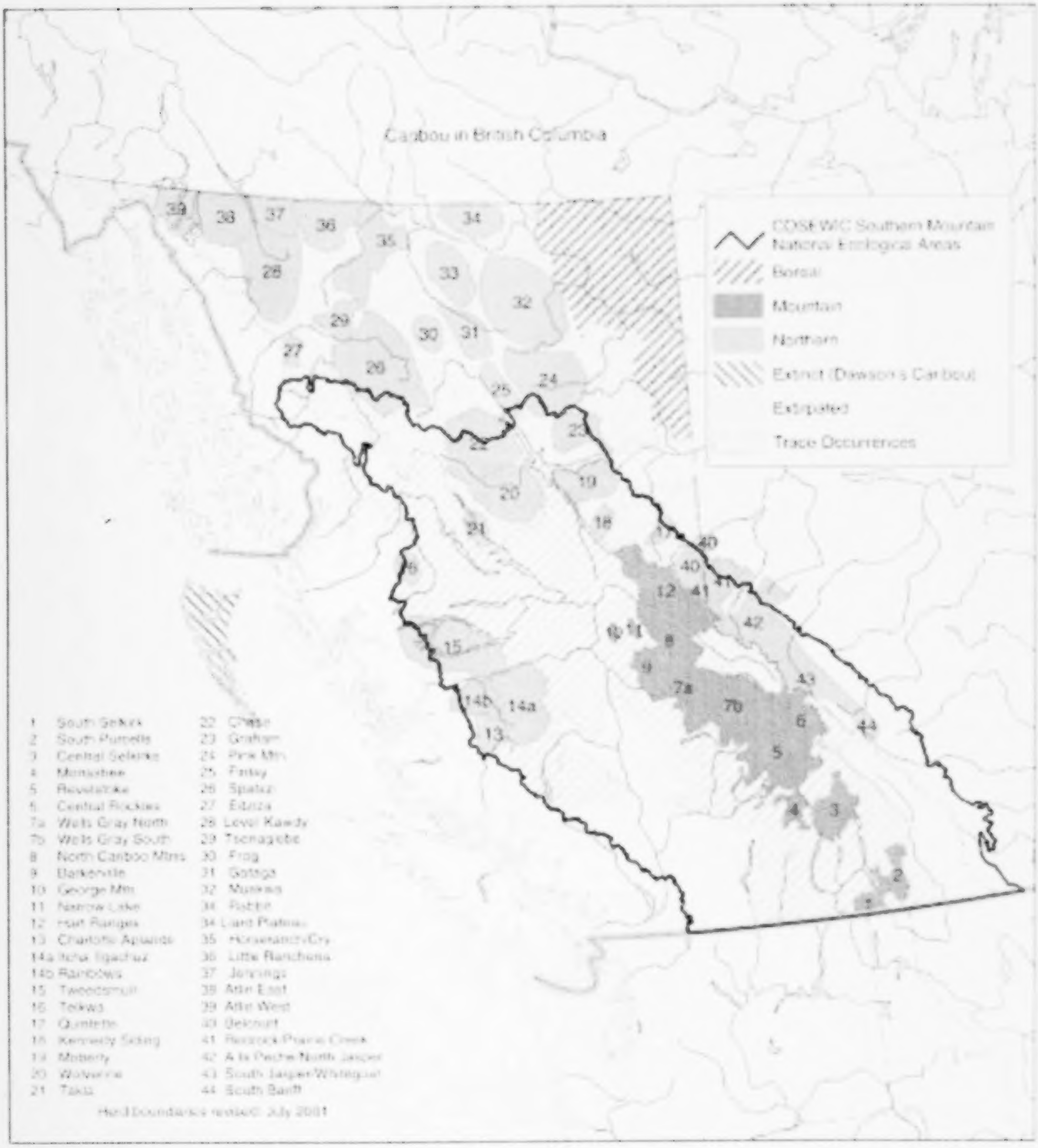
Global

Rangifer tarandus has a circumboreal distribution. In northern Europe and Asia, this species is known as Reindeer, and includes domestic, semi-domesticated, and wild populations. In North America, the species is known as Caribou and exists primarily in the wild. Extant wild subspecies in North America are:

1. Barren-ground Caribou from just south of the treeline northward in northernmost Saskatchewan and Manitoba, the Northwest

Table 1. Features of caribou ecotypes in British Columbia

Feature	Mountain Caribou	Northern Caribou	Boreal Caribou
Occurrence	Mountainous deep-snowpack portion of southeastern British Columbia known as the Interior Wet Belt	Mountainous and adjacent plateau areas with relatively low snowpacks in west-central and northern Interior British Columbia	Peatlands (muskeg) in lowland plateau portion of northeastern British Columbia, east of the Rocky Mountains, with relatively low snowpack
Winter diet	Consists almost entirely of arboreal hair lichen, with use of terrestrial lichen and other ground-based foods only in early winter	Consists mostly of terrestrial lichens with use of arboreal lichens dependent on snow conditions	Consists mostly of terrestrial lichens with some use of arboreal lichens
Seasonal movements	Generally involve little horizontal distance but strong elevational shifts	Generally involve both horizontal distance and elevational shifts	Generally involve horizontal distance but no strong elevational shifts although for some local populations, winter and summer ranges may overlap


Caribou in British Columbia
COSEWIC Southern Mountain National Ecological Areas
Boreal
Mountain
Northern
Extinct (Dawson's Caribou)
Extirpated
Trace Occurrences
1 South Selkirk
2 South Purcells
3 Central Selkirks
4 Monashee
5 Revelstoke
6 Central Rockies
7a Wells Gray North
7b Wells Gray South
8 North Cariboo Mtns
9 Barkerville
10 George Mtn
11 Narrow Lake
12 Hart Ranges
13 Charlotte Alplands
14a Itcha Ilgachuz
14b Rainbows
15 Tweedsmuir
16 Telkwa
17 Quintette
18 Kennedy Siding
19 Moberly
20 Wolverine
21 Takla
22 Chase
23 Graham
24 Pink Mtn
25 Finlay
26 Spatsizi
27 Edziza
28 Level Kawdy
29 Tsenaglode
30 Frog
31 Gataga
32 Muskwa
33 Rabbit
34 Liard Plateau
35 Horseranch/Cry
36 Little Rancheria
37 Jennings
38 Atlin East
39 Atlin West
40 Belcourt
41 Redrock/Prairie Creek
42 A la Peche/North Jasper
43 South Jasper/Whitegoat
44 South Banff
Herd boundaries revised: July 2001

Territories, Nunavut, and western Greenland, totaling over 1 million;

2. Alaska Caribou in northern Yukon and much of Alaska, totalling ~1 million;
3. Peary Caribou on the Arctic islands of the Northwest Territories and western Nunavut, totalling ~2000;
4. Woodland Caribou in southern Yukon, southwestern Northwest Territories, northern, west-central and southeastern British Columbia, extreme northeastern Washington, extreme northern Idaho, west-central and northern Alberta, boreal portions of Saskatchewan and Manitoba, and the boreal and arctic portions of Ontario, Quebec, and Newfoundland and Labrador, totalling over 1 million.

Of the three Woodland Caribou ecotypes in British Columbia, Mountain Caribou occur in part of the Columbia Mountains, Idaho, and Washington, and a small portion of the west slope of the Rocky Mountains in British Columbia. Northern Caribou are found in mountainous and adjacent low elevation plateau areas in west-central British Columbia and in northern British Columbia west of and in the Rocky Mountains. Boreal Caribou are found in relatively flat boreal forests east of the Rocky Mountain in northeastern British Columbia.

British Columbia

Mountain Caribou in British Columbia occur regularly in portions of the Rocky Mountains' west slope from the Anzac River to the Morkill River, and from the Wood River drainage to the Bush Arm of Kinbasket Lake, although there are sporadic occurrences between the Morkill and Wood rivers. They also occur in the Columbia Mountains, including parts of the Cariboo Mountains, Quesnel Highlands, Shuswap Highlands, Monashee Mountains north of Whatshan Lake, Selkirk Mountains, and parts of the Purcell Mountains north of Highway 3.

Northern Caribou occur in west-central British Columbia, in and around the Itcha, Ilgachuz, Rainbow, and Trumpeter mountains as well as in and around northern Tweedsmuir Provincial Park and Entiako Provincial Park and Protected Area. They also occur in the Telkwa Mountains and around the northern part of Takla Lake. Northern Caribou are somewhat contiguous in distribution from the Williston Lake area north to the Yukon border and northwest to Atlin, and southeast along the east side of the Rocky Mountains to the Alberta border near Kakwa Park.

Boreal Caribou are found in approximately 15% of the province east of the Rocky Mountain foothills from the Yukon border east of the Liard River as far south as the Wapiti River Drainage downstream of its junction with the Red Deer River. The western boundary is indistinct but is approximately along the Liard River from the Yukon, North West Territories' boundary upstream as far as the junction with the Dunedin River, and then generally southeast to Fort St John. No caribou were likely to have or will live in the drier aspen forests along the lowlands near the Peace River although the occasional transient has been seen in these areas.

Forest regions and districts

Mountain Caribou		Northern Caribou		Boreal Caribou	
Region	**District**	**Region**	**District**	**Region**	**District**
Southern Interior	100 Mile House Arrow Boundary Central Cariboo Columbia Headwaters Kootenay Lake Okanagan Shuswap Quesnel Rocky Mountain	Southern Interior	Chilcotin Quesnel	Northern Interior	Peace Fort Nelson
		Norther Interior	Fort Nelson Fort St. James Mackenzie Nadina Peace Prince Geroge Skeena Stikine Vanderhoof		
Northern Interior	Prince George	Coast	North Island		

Ecoprovinces and ecosections

Mountain Caribou	Northern Caribou	Boreal Caribou
SBI: HAF	BOP: HAP, KIP	BOP: CLH, HAP, KIP
SIM: BBT, BOV, CAM, CCM, CPK, EPM, NKM, NPK, QUH, SCM, SHH, UFT	CEI: BUB, BUR, CHP, NAU, NEU, WCR, WCU	TAP: ETP, FNL, MAU, MUP, PEP, TLP
	COM: CRU, KIR, NAB, NAM	
	NBM: CAR, EMR, HYH, KEM, LIP, MUF, SBP, STP, TAH, TEB, TEP, TUR, WMR	
	SBI: BAU, ESM, HAF, MAP, MIR, PEF, SOM	
	SIM: FRR	
	TAP: MUP	

Biogeoclimatic units

ICH, ESSF, and AT occur over the majority of Mountain Caribou range and are used to varying degrees. Caribou in the northern end of the distribution (Hart Ranges, Narrow Lake, George Mountain, Barkerville, and North Cariboo Mountains local populations) use the SBS instead of or in addition to ICH. In portions of the South Purcell local population, the MS zone occurs in place of ICH, but there is very little use of the MS there.

Northern Caribou use a wide range of biogeoclimatic subzones and variants, partly because of the extent of their distribution throughout northern and west-central British Columbia. AT is used by most Northern Caribou local populations during both winter and summer. In the northern part of British Columbia, low elevation forested winter ranges occur in the BWBS zone and higher elevation ranges occur in the SWB. In north-central British Columbia, Northern Caribou low elevation winter ranges occur in SBS and BWBS, with high elevation ranges in ESSF. In west-central British Columbia, low elevation winter ranges occur in SBS, SBPS, and to some extent in the MS with high elevation ranges in the ESSF. In addition, some Northern Caribou summer range in west-central British Columbia lies within the MH at higher elevations and CWH at lower elevations.

Boreal Caribou can occur in all of the variants of the BWBS with the possible exception of the BWBSdk2.

However, the majority occur in the BWBSmw1 and BWBSmw2, which contain the wetter site series that include "peatlands" or "muskeg."

Mountain Caribou	Northern Caribou	Boreal Caribou
ESSFdk	BWBSdk1	BWBSmw1
ESSFmm	BWBSdk2	BWBSmw2
ESSFp	BWBSmw1	BWBSwk2
ESSFun[a]	BWBSwk1	BWBSwk3
ESSFvc	BWBSwk2	
ESSFvv	CWHws2	
ESSFwc	ESSFmv2	
ESSFwk	ESSFmv3	
ESSFwm	ESSFmv4	
ICHmk (limited)	ESSFwc3	
ICHmm	ESSFwk2	
ICHmw	ESSFwv	
ICHvk	ESSFwv1	
ICHwk	MHmm2	
MSdk	MSxv	
	SBPSmc	
SBSvk	SBPSmk	
SBSwk	SBPSxc	
	SBSdk	
	SBSmc2	
	SBSmc3	
	SBSmk1	
	SBSmk2	
	SBSwk2	
	SBSwk3	
	SWBmk	
	SWB (undiff)	

a A distinct subzone or variant occurs in some locations between the ESSF proper and the ESSFp, with a lower boundary where alpine larch and heathers begin (T. Braumandl, pers. comm.). This "undifferentiated" subzone has not yet been named but tentative site series for it have been identified in parts of the Kootenay region.

Broad ecosystem units

Degree of use of broad ecosystem units (BEUs) varies between local populations.

Mountain Caribou		Northern Caribou		Boreal Caribou
AH[a]	ME[c]	**AC**	**HP**	**BB**
AM	RD[c]	**AS**	**LP**	**BG**
AN[b]	RE[b,c]	**BA**	**LS**	**BL**
AT	RR	**BB**	**MI**	**BP**
AU[b]	SF[c]	**BK**	**OW**	**LP**
AV	SK	**BS**	**RD**	**LS**
EF	**SM**	**CD**	**RE**	**PR**
ER	TA[b]	**CF**	**RR**	**WL**
EW	TC[b]	**CS**	**SP**	
FP	TR[b]	**CW**	**SR**	
GL[b]	WB[c]	**FR**	**TA**	
IH	WG	**FS**	**TF**	
IS	WP[c]	**GB**	**UR**	
LL[b]		**GL**	**UV**	
LS[b]				

a Units in bold are used most consistently among local populations.

b Units used for travel or resting only.

c Units used by three or fewer local populations.

Elevation

Mountain Caribou activity is most concentrated in the upper portion of the ESSF zone, at ~1500–2100 m. However, elevation use varies by local population, year, season, and individual. Local populations occurring near the centre of current range and in areas with greater extremes of elevation tend to make more extensive use of elevations as low as 600 m for foraging, particularly in early winter and spring. Caribou in other locations are more likely to use lower elevations mainly as they cross valleys between high-elevation ranges. Sometimes elevations >2500 m are used, particularly in the summer.

Northern Caribou are found at a variety of elevations depending on season and local population. During winter, Northern Caribou are generally found either at high elevations above treeline on windswept alpine slopes or at lower elevations in forested habitat. Due to the extent of Northern Caribou range in British Columbia, lower elevation forested habitat can range from about 500 to 1500 m depending on local population. High elevation winter habitat generally ranges from 1500 m to over 2000 m. Some high elevation winter range also includes subalpine forests. During summer, Northern Caribou may be found as low as 500 m in coastal areas in west-central British Columbia to over 2500 m in mountainous areas in most local population ranges.

Boreal Caribou are found in relatively flat boreal forests in northeastern British Columbia where they occupy all elevations in that area from about 400 to 1200 m.

Life History

Diet and foraging behaviour

The late-winter diet of Mountain Caribou consists almost entirely of *Bryoria* spp., with some *Alectoria sarmentosa* and possibly *Nodobryoria oregana*. They are able to sustain themselves on this low-protein diet (*Bryoria* has only about 4% crude protein; Rominger et al. 1996), for roughly half of the year (Rominger et al. 2000). The dependence on arboreal hair lichens is probably the result of several factors. Hair lichens are usually abundant in old forests, which have historically been extensive in the interior Wet Belt, while terrestrial lichens are not. Furthermore, deep snowpacks in this region preclude cratering for most of the winter while providing lift to allow caribou to reach lichen higher in the trees. The use of forbs and graminoids increases dramatically in the spring season. Summer food consists of a wide variety of forbs, graminoids, lichens, fungi, and the leaves of some shrubs. Depending on location and year, early winter foraging may be largely restricted to the same hair lichen species as during late winter, particularly those on windthrown trees or branches, but generally also includes a variety of winter-green shrubs, forbs, graminoids, and terrestrial lichens.

During winter, Northern Caribou forage primarily by cratering through the snow for terrestrial lichens of the genera *Cladina*, *Cladonia*, *Cetraria*, and *Stereocaulon*. *Cladina* spp. are preferred but the other genera are also selected. Northern Caribou also feed on arboreal lichens opportunistically as they travel between terrestrial lichen sites or seek arboreal lichens in forested wetlands and along wetland fringes where arboreal lichens are abundant. Arboreal lichen use increases as snow hardness increases later in winter with melt/freeze conditions. During milder winters, frequent melt/freeze episodes could make cratering for terrestrial lichens difficult earlier in the winter, especially when ice crusts form close to the ground, forcing caribou to increase their reliance on arboreal lichens. *Bryoria* spp. are the most abundant arboreal lichens on most Northern Caribou winter ranges. Because of the relatively low snowpacks on most Northern Caribou winter ranges, caribou can forage on terrestrial lichens either in low elevation forested habitats, or on windswept alpine slopes. Similar to Mountain Caribou, the use of forbs and graminoids increases dramatically in the spring season and summer food consists of a wide variety of forbs, graminoids, lichens, fungi, and the leaves of some shrubs.

Less is known about Boreal Caribou foraging behaviour in British Columbia; however, Boreal Caribou, like Northern Caribou, also appear to forage primarily on terrestrial lichens and to a lesser extent on arboreal lichens during winter. Winter foraging occurs primarily in very open forests in peatlands and to a lesser extent in nearby lichen-rich pine stands where available. Presumably, summer food also consists of a wide variety vegetation.

Reproduction

The mating system of Woodland Caribou is polygynous, with dominant bulls breeding with a number of cows in late September to mid-October. Rutting group size varies between ecotype with up to a dozen for Mountain Caribou, up to 20 (or more) for Northern Caribou, and generally <5 for Boreal Caribou. Woodland Caribou in British Columbia exhibit a number of anti-predator strategies during calving including calving alone in isolated, often rugged locations (Mountain, Northern), calving on islands in lakes in low elevation forested habitat (Northern, possibly Boreal), calving in large muskegs where the number of predators and other prey are low (Boreal), and dispersing away from other caribou and prey in low elevation forested areas (Boreal) (Shoesmith and Storey 1977; Bergerud et al. 1984a; Bergerud and Page 1987).

The productivity of caribou is low compared with deer and moose because caribou only have one young per year and calves and most yearlings commonly are not pregnant. The population growth rate (l) rarely exceeds 1.26, or 26% per year. Pregnancy rate of females ranges from 90 to 97% (Seip and Cichowski 1996). Gestation is about 230 days, and calves are born in late May or early June. Calves are notably precocious, moving with their mothers shortly after birth. Calf mortality during the first few months of life is high, often 50% or greater. Causes of calf mortality may include predation, abandonment, accidents, and inclement weather. Calves generally make up 27–30% of the population at birth, but by recruitment age (1 yr old, after which mortality generally stabilizes to adult levels), their proportion is generally <20%.

Site fidelity

Fidelity patterns are complex. Some cows calve in the same location repeatedly, while others shift locations annually. Similarly, rutting sites may be occupied each year or only sporadically. Home ranges rarely remain fixed throughout an animal's life. Individual caribou typically use a predictable series of activity centres over a season or several years, but most eventually make temporary or permanent shifts to new areas. From spring through early winter, individuals may travel with several other caribou temporarily, and then shift to another band. Membership in late-winter aggregations is also inconsistent between years. At the local population level, fidelity to broad landscapes is stronger, but even at this scale there are occasional shifts of individuals and groups to areas that were not used for the past several years. Consistent use of mineral licks has been reported.

Home range

For Mountain Caribou, minimum convex polygon home ranges of 150–600 km^2 are typical, but vary from <100 to >800 km^2. For Northern Caribou, home range sizes are highly variable depending on local population size and the horizontal movement distance between summer and winter ranges. In northern and north-central British Columbia home ranges average 1100–1900 km^2 for some local populations and 150 km^2 for another (Hatler 1986; Terry and Wood 1999; Wood and Terry 1999; Poole et al. 2000). For Boreal Caribou in Alberta, home ranges averaged 710 km^2 (Stuart-Smith et al. 1997).

Movements and dispersal

Mountain Caribou

During late winter (Table 2), Mountain Caribou aggregate in open stands in or near the ESSF parkland, feeding predominantly on *Bryoria*. While there is often abundant arboreal lichen at lower elevations, the tendency to use higher elevations may result from a combination of the increased lift and support provided by a deeper snowpack, the predominance

Table 2. Approximate dates for Mountain Caribou seasons[a]

	Approximate dates	
Season	**Stevenson et al. (2001)**	**Simpson et al. (1997)**
Late winter	mid-January – April	mid-January – mid-April
Spring	mid-April – late May	mid-April – May
Summer	June – late October	June – October
Early winter	late October – mid-January	November – mid January

[a] Seasonal changes are often marked by distinct elevation shifts, and actual dates vary between local-populations, individuals, and years (see Apps et al. 2001).

of *Bryoria* rather than *Alectoria*, the near absence of wolves and cougars (which typically follow the more abundant ungulates to lower elevations in the winter), and the improved ability to see remaining predators (e.g., wolverines) in the open stands typical of higher elevations. During spring, the snowpack at this elevation loses its ability to support caribou, and individuals or small groups move to either exposed sites in the upper ESSF or AT or snow-free elevations in the ICH or lower ESSF to feed on newly emerged green vegetation. In June, pregnant cows ascend individually to high, exposed locations in the ESSF or AT to calve. Such sites offer safety from most predators and relief from biting insects. During summer, caribou typically occur in small groups within the upper ESSF and AT, although there is periodic summer use of the lower ESSF in many local populations, particularly in late August or early September. From mid-September through October, Mountain Caribou beginning aggregating again for the rut. As snow accumulates in early winter, rut groups break up and most local populations shift down slope into the ICH to mid-ESSF, where snow depths are reduced due to lower elevation and greater canopy closure. Foraging at this time is variable. Arboreal lichen on windthrown trees and branches is heavily used, and caribou also crater for terrestrial lichens and winter-green forbs and shrubs such as falsebox (*Pachistima myrsinites*). As snow depth exceeds 50 cm, cratering becomes less energetically efficient and caribou move into late-winter habitat. Habitat shifts between early winter and late winter may occur as a series of events, with downward movement after major snowfalls followed by upward movement as the snow consolidates, until caribou more permanently settle into late-winter habitat in about January.

Most Mountain Caribou appear to stay within the local population in which they were born. In fact, the 13 recognized local populations may under-represent the true number of areas between which there is no to very limited movement. However, temporary movements are occasionally reported between local populations, from established local populations into unused areas, and even into the range of other ecotypes.

Northern Caribou

Although Northern Caribou are characterized by feeding primarily on terrestrial lichens during winter, local populations in British Columbia exhibit variable seasonal movement and habitat use strategies. Some local populations migrate long distances between summer and winter ranges while others do not. Use of high elevation versus low elevation winter ranges differs between local populations, and within local populations between winters. Variation in seasonal behaviour reflects differences in topography, snow accumulation, and availability of low elevation winter ranges between areas. In general, Northern Caribou habitat use in British Columbia can be described using four seasonal time periods similar to Mountain Caribou. Exact dates vary for each population depending on local conditions.

Snowfall in November triggers caribou movement out of high elevation summer ranges to lower elevation early winter ranges. Early winter ranges may be adjacent to the summer range or some distance away. At this time, caribou continue to seek out terrestrial forage and avoid deeper snow accumulations where terrestrial forages are difficult to access. Fall migration between summer and winter ranges tends to be diffuse as caribou migrate in response to snow accumulation.

During early winter, snow depth at low elevations may be highly variable between years. In general, snow depth on low elevation winter ranges is lowest during early winter and gradually increases as the winter progresses. Shallower snow depths in early winter allow caribou to use the higher and more open portions of their forested plateau winter ranges (Itcha-Ilgachuz), or low elevation forested habitats (Wolverine) that are abandoned as snow accumulates during mid- to late-winter.

By mid- and late-winter, caribou have moved to low elevation forested winter ranges, or high elevation alpine/subalpine winter ranges to feed primarily on terrestrial lichens. In low elevation forested habitat, caribou prefer forests where terrestrial lichens are abundant; these are often on drier sites or sites with low productivity and in older forests (80–250 yr). Caribou also feed on arboreal lichens opportunistically as they travel between terrestrial lichen sites or seek arboreal lichens in forested wetlands and along wetland fringes where arboreal lichens are abundant. At higher elevations, caribou prefer windswept alpine slopes for cratering for terrestrial lichens. Subalpine forests are also used for arboreal lichen feeding, and to a lesser extent, terrestrial lichen feeding.

By late April, caribou that migrate between winter and summer ranges begin moving back to calving and summering areas. Spring migration is more concentrated than fall migration both geographically and temporally. During spring, caribou migrate along relatively snow-free low elevation routes to reach summer ranges (Cichowski 1993; Johnson et al. 2002). Caribou that winter at higher elevations move to lower elevations in spring to take advantage of an earlier green-up. Spring ranges may be adjacent to late-winter ranges or may be a function of migration patterns. Female caribou reach calving areas by late May and calve in early June. Most caribou calve at higher elevations in alpine or subalpine habitat where food availability and quality is relatively poor to reduce predation risk since predators focus on other prey that remain at lower elevations where more nutritious forage is available.

During summer, caribou prefer high elevation habitats but can be found in a variety of habitats at all elevations because snow does not limit movement, and herb and shrub forage are abundant. Consequently, Northern Caribou are highly dispersed during summer, more so than during any other season. During the rut in October, some caribou move to rutting areas at higher elevations while others rut within their summer ranges. Portions of some local populations concentrate on rutting ranges, usually in open alpine or subalpine habitat.

Although studies of radio-collared Northern Caribou populations indicate that range use by adjacent local populations may overlap, especially during winter, all radio-collared caribou return to their summering areas. Northern Caribou may potentially be dispersing between local populations but no studies have yet reported any evidence of dispersal by radio-collared animals.

Boreal Caribou

Boreal Caribou do not appear to live in discrete herds but exist in small, dispersed, relatively sedentary bands throughout the year (Edmonds 1991; Heard and Vagt 1996). Although there is no specific published information on movements and habitat use by Boreal Caribou in British Columbia, studies from Alberta provide some general information that could be extrapolated to British Columbia. Boreal Caribou in northern Alberta make extensive movements or "wander" throughout the year (Hornbeck and Moyles 1995; Stuart-Smith et al. 1997) but most do not appear to make predictable seasonal migrations (Dzus 2001). Therefore, winter and summer ranges typically overlap and habitat use does not differ by season (Dzus 2001).

Habitat

Table 3 summarizes habitat characteristics of Woodland Caribou ranges in British Columbia. All habitat features are required to support Woodland Caribou populations.

Structural stage

For Mountain Caribou, structural stage 7 is consistently preferred throughout most of the year for forage, predator avoidance (typically good lines of sight and only dispersed populations of other ungulates), ease of travel, snow interception in early winter, and possibly heat avoidance in the summer (Apps and Kinley 2000a, 2000b, 2000c; Apps et al. 2001). Structural stage 6 also provides useful habitat, particularly the older and more open end of the stage. Other structural stages are used to varying degrees. Structural stage 1a and 1b are used for calving sites when occurring in rough terrain (June), predator avoidance (good line of site), insect avoidance (spring and summer), and resting areas. Structural stages 2 and 3a provide moderate to high forage value in spring and summer but also provide forage for other ungulates, especially below treeline. The least valuable stands to caribou are those in stages 3b, 4, and 5, where line of site is poor for

Table 3. General habitat requirements for Mountain Caribou, Northern Caribou, and Boreal Caribou in British Columbia

Feature	Mountain Caribou	Northern Caribou	Boreal Caribou
Winter food supply	Access to an adequate supply of accessible arboreal lichen	Access to an adequate supply of terrestrial and arboreal lichens	Access to an adequate supply of terrestrial and arboreal lichens
Snow conditions	Snow conditions that allow caribou to travel on top of the snowpack in subalpine areas where they can access arboreal lichens and where avalanche danger is low	Snow interception by forest canopy to allow movements within the winter range	Snow conditions and frozen ground conditions to allow movements through peatlands
Winter range	Large tracts of winter range where caribou can exist at low densities as an anti-predator strategy and rotate their winter ranges		
Calving habitat	Relatively undisturbed high elevation calving habitat where caribou can disperse widely and calve in isolation away from predators	Relatively undisturbed high elevation calving habitat or low elevation forested calving habitat on islands where caribou can disperse widely and calve in isolation away from predators	Large tracts of relatively undisturbed peatland complex calving habitat where caribou can disperse widely and calve in isolation away from predators

predator avoidance and forage value is generally low for caribou but can be high for other ungulates, especially moose (3b). In some cases, these stages may form partial barriers to movement and act to isolate adjacent patches of habitat from one another. Structural stage use by Northern Caribou is similar to Mountain Caribou except that Northern Caribou may forage in structural stage 5, where, in some areas and ecosystems, forage (terrestrial lichens) may be abundant. Less is known about Boreal Caribou; however, they appear to prefer structural stages 1a to 3a, 6, and 7 within muskeg complexes and 6 and 7 in adjacent pine–lichen forests throughout the year.

Important habitats and habitat features

Security and foraging

Security and foraging habitat are typically the same thing for Woodland Caribou on the forested portions of their ranges, at least at broader spatial scales. For Mountain and Northern Caribou, both functions are provided by large, contiguous patches of old forest and for Boreal Caribou, both functions are provided by the older forest component of peatland (muskeg) complexes. Specific values of such areas are as follows:

1. There are generally fewer Elk (*Cervus elaphus*), Deer (*Odocoileus* spp.) or Moose (*Alces alces*) within old-growth forests on Mountain and Northern Caribou ranges and within peatland complexes on Boreal Caribou ranges than in or near non-forested areas (avalanche tracks, meadows, shrubby riparian zones, recent clearcuts), as this more abundant suite of other ungulate species tends to concentrate in early-seral sites with abundant shrubs and forbs. Thus, the predators of other species also tend to occur less commonly within old forest than at the edge or outside of old forest or in peatland complexes. For Northern and Mountain Caribou, habitat fragmentation due to the creation of early seral patches within old forest is likely to bring other prey species close to caribou, resulting in a greater incidence of predator encounters (Kinley and Apps 2001). The potential for increased prey populations on some very dry Northern Caribou ranges may be somewhat reduced where shrub

regeneration following disturbance is less pronounced (e.g., Itcha-Ilgachuz caribou winter range). Similarly, in undisturbed areas for Boreal Caribou, habitat fragmentation due to the creation of linear disturbance and the connection of early seral patches by linear disturbances within peatland complexes is likely to provide "predator trails" and bring other prey species closer to caribou, resulting in a greater incidence of predator encounters (Dyer 1999; Kinley and Apps 2001). This pattern is consistent with that found among other caribou ecotypes, in which the major habitat variable that affects numbers is space to avoid predation (Bergerud 1980; Bergerud et al. 1984a; Bergerud 1992).

2. Old forests typically have good visibility relative to younger forests, due to open stand architecture, leading to an improved ability to detect those predators that do occur there. For Boreal Caribou, peatlands also have good visibility.
3. Arboreal hair lichen such as *Bryoria* are usually abundant only in older forests. Terrestrial lichens such as *Cladina*, *Cladonia*, and *Cetraria* are often most abundant in mature and older forests but are also abundant in younger forests on some site types.
4. Old trees with large crowns provide good snow interception, which facilitates cratering and movement during early winter (Mountain Caribou, Northern Caribou, Boreal Caribou) and winter (Northern Caribou, Boreal Caribou).
5. For Mountain and Northern Caribou, the more contiguous that foraging habitat is, the less energy is expended in moving between patches.
6. For Mountain Caribou, sunlight is screened before reaching understorey plants in old forests with heavy canopies, reducing the development of unpalatable or harmful compounds in forage plants (Rominger et al. 2000) and increasing the retention of moisture to maintain plant vigour during summer dry periods.
7. Old forests and peatland complexes provide a cooler microclimate during summer.
8. The suite of forage plants in old forest is different than that available in other habitat types.

Thus, old forests provide far more than simply lichen for late-winter foraging, and old forests are selected across seasons and a range of spatial scales. On Mountain Caribou ranges, old stands of subalpine fir (*Abies lasiocarpa*) and Engelmann spruce (*Picea engelmannii*) are widely used among caribou of all local populations, including both closed-canopy and parkland stands across a range of soil moisture conditions (see "Broad ecosystem units" above). However, tree species composition shows some variability between regions. On Northern Caribou ranges, old stands of lodgepole pine (*Pinus contorta*) or lodgepole pine and white spruce (*Picea glauca*) in low elevation forested habitat are widely used by most local populations. Boreal Caribou commonly use large patches of peatland with disconnected old forest.

Mountain Caribou also use alpine habitat during summer and Northern Caribou use alpine habitat during summer and winter. Boreal Caribou do not have access to alpine habitats and therefore do not use them. Alpine habitats also provide both forage and security features. During summer, emergent vegetation provides nutritious forage and open vistas provide good visibility for detecting predators. For Northern Caribou, during winter windswept alpine slopes also provide access to terrestrial lichens and good visibility for detecting predators.

For Woodland Caribou generally, the risk of predation is further reduced by existing at very low population densities of ~0.03–0.12 caribou/km^2 (Edmonds 1988; Seip 1991; Bergerud 1992; Stuart-Smith et al. 1997). The availability of extensive range space is thought to be an important habitat characteristic that allows Woodland Caribou to avoid predation (Bergerud 1980; Bergerud et al. 1984). All three ecotypes of Woodland Caribou use "space" to avoid predation, especially during calving. Mountain and Northern caribou move into high elevation habitat, forgoing nutritious forage at lower elevations to seek out remote locations for calving, separated from other caribou and prey, and predators.

Breeding

Calving sites and rut locations are also vulnerable habitat elements, but predicting their locations by habitat type is not feasible. Calving sites are dispersed, may vary between years, and appear to be defined primarily on the basis of isolation from other caribou, other ungulates, and predators. Rutting sites are likely to be more consistent between years, but can be effectively located only with site-specific knowledge gained by monitoring individual caribou local populations.

The most critical aspect of Mountain Caribou and Northern Caribou ranges is access to undisturbed high elevation calving range. In fact, access to undisturbed high elevation calving ranges where caribou can distance themselves from other prey and predators, is the common feature among Mountain Caribou and Northern Caribou local populations that exist today. Historically occurring local populations of Mountain Caribou and Northern Caribou without access to high elevation calving ranges no longer exist in British Columbia.

Mineral licks

Another vulnerable habitat element is mineral licks. Licks are consistently used between years, but can be effectively located only by monitoring individual local populations of caribou.

Conservation and Management

Status

In British Columbia, Mountain Caribou are on the provincial *Red List*, Boreal Caribou are on the provincial *Blue List*, and Northern Caribou in the Southern Mountains National Ecological Area (SMNEA) and in the Northern Mountains National Ecological Area (NMNEA) are on the provincial *Blue List* (Table 4). In Canada, all Woodland Caribou within the entire SMNEA, including all Mountain Caribou and some Northern Caribou local populations in British Columbia, are considered *Threatened* (COSEWIC 2002). Boreal Caribou are also considered Threatened and Northern Caribou in the NMNEA are considered of *Special Concern*.

Trends

Population trends

Mountain caribou

About 99% of the world's 1900 Mountain Caribou live within British Columbia. The B.C. Ministry of Water, Land and Air Protection considers Mountain Caribou to occur as 13 local populations within a metapopulation of 1900 (Hatter et al. 2002). Six of those local populations have 50 or fewer individuals, and 8 are declining; no local populations are increasing (Table 5).

According to local population risk assessment criteria, seven local populations are considered Endangered, one local population is considered Threatened, and five local populations are considered Vulnerable. About 43% of the historic range of Mountain Caribou is no longer occupied, and it is believed that populations have been reduced correspondingly. One estimate of the pre-colonial population of Mountain Caribou (excluding the United States) is 5000–6000 (Demarchi 1999).

Northern caribou

In 2002, there were an estimated 5235 Northern Caribou within the SMNEA and 11 000 Northern Caribou within the NMNEA in British Columbia (Table 6). While numbers may have increased slightly since the late 1970s, it is likely that some of the "apparent" increase is from more intensive survey effort, combined with recent radio-telemetry studies, which has enabled a more reliable status assessment of this ecotype.

Currently, Northern Caribou in the SMNEA are distributed within 13 local populations, which form two metapopulations. The west-central metapopulation includes the Charlotte Alplands, Itcha-Ilgachuz, Rainbows, Tweedsmuir-Entiako, and status of three local populations was unknown. Four local populations have 100 or fewer animals. According to local population risk criteria, two local populations are considered Endangered, six local populations are considered Threatened, four local populations are considered Vulnerable, and one local population is considered Not At Risk. An overall increase in

Table 4. Summary of Woodland Caribou status in British Columbia

	Status			
Ecotype	**Global**	**Provincial**	**COSEWIC (May 2002)**	**BC status**
Dawson Caribou	G5TX	SX	Extinct	Extinct
Mountain Caribou	G5T2Q	S2	Threatened	Red
Northern Caribou (SMNEA)	G5T4	S3S4	Threatened	Blue
Northern Caribou (NMNEA)	G5T4	S3S4	Special Concern	Blue
Boreal Caribou	G5T?	S3	Threatened	Blue

Table 5. Current population estimate (2002), trend, risk status, and density of Mountain Caribou local populations in British Columbia

Local population	Local population estimate	Recent trend[a]	Local population risk status[b]	Risk criteria[c]	Range[d] (km^2)	Density (no./1000 km^2)
South Selkirks	35	Declining	EN	A1	1 500	23
South Purcells	20	Declining	EN	A1	2 962	7
Central Selkirks	130	Declining	EN	A3	4 813	27
Monashee	10	Declining	EN	A1	2 082	5
Revelstoke	225	Declining	VU	A1	7 863	29
Central Rockies	20	Declining	EN	A1	7 265	3
Wells Gray North	220	Declining	VU	A1	6 346	35
Wells Gray South	325	Stable	VU	A1	10 381	31
North Cariboo Mountains	350	Stable	VU	A1	5 911	59
Barkerville	50	Stable	EN	A1	2 535	20
George Mountain	5	Declining	EN	A1	441	11
Narrow Lake	65	Stable	TR	A1	431	151
Hart Ranges	450	Stable	VU	A1	10 261	44
TOTAL	1 905				62 791	30

[a] Recent trend defined as trend over last 7 years (1 generation length). Trend based on >20% change.

[b] At risk status based on Thomas and Gray (2001), draft guidelines for quantitative risk assessment of local populations.
EN = Endangered; NAR = Not at Risk; TR = Threatened; VU = Vulnerable.

[c] Risk criteria (from Thomas and Gray 2001), see Hatter et al. (2002, Appendix 3).

[d] Current occupied range.

Table 6. Current population estimate (2002), trend, risk status, and density of Northern Caribou local populations in British Columbia

Local population	Population estimate	Recent trend[a]	Local population risk status[b]	Risk criteria[c]	Range[d] (km²)	Density (no./1000 km²)
Southern Mountains National Ecological Area						
Charlotte Alplands	50	Declining	EN	A1	2 650	19
Itcha-Ilgachuz	2 500	Increasing	NAR	A1	9 457	264
Rainbows	125	Stable	TR	A2	3 804	33
Tweeasmuir-Entiako	300	Declining	TR	A3, C3	12 811	23
Telkwa	55	Increasing	EN	A1	1 828	30
Quintette	200	Unknown	VU	A1	1 421	141
Kennedy Siding	170	Increasing	VU	A1	1 470	116
Moberly	170	Declining	TR	A2	5 115	33
Wolverine	590	Increasing	VU	A1	8 315	71
Takla	100	Unknown	TR	A1	1 850	54
Chase	575	Stable	VU	A1, A2	11 390	50
Graham	300	Declining	TR	A3	4 734	63
Belcourt	100	Unknown	TR	A1	2 045	49
TOTAL	5 235				66 890	78
Northern Mountains National Ecological Area						
Pink Mountain	850	Declining	VU	A1	11 602	73
Finlay	200	Unknown	VU	A1	3 084	65
Spatsizi	2 200	Stable	NAR	A1	16 929	130
Mount Edziza	100	Unknown	TR	A1	1 281	78
Level-Kawdy	1650	Stable	NAR	A1	12 568	131
Tsenaglode	200	Unknown	VU	A1	3 015	66
Frog	150	Unknown	VU	A1	2 421	62
Gataga	250	Unknown	VU	A1	4 437	56
Muskwa	1 250	Unknown	NAR	A1	16 786	74
Rabbit	800	Unknown	VU	A1	5 936	135
Liard Plateau	150	Stable	VU	A1	5 069	30
Horse Ranch/Cry Lake	850	Stable	VU	A1	9 499	89
Little Rancheria	1 000	Stable	NAR	A1	7 431	135
Jennings	200	Unknown	VU	A1	4 080	49
Atlin East	800	Stable	VU	A1	7 053	113
Atlin West	350	Stable	VU	A1	4 398	80
TOTAL	11 000				115 590	95

a Recent trend defined as trend over last 7 years (1 generation length). Trend based on >20% change.

b At risk status based on Thomas and Gray (2001), draft guidelines for quantitative risk assessment of local populations. EN = Endangered; NAR = Not at Risk; TR = Threatened; VU = Vulnerable.

c Risk criteria (from Thomas and Gray 2001), see Hatter et al. (2002, Appendix 3).

d Current occupied range.

Northern Caribou numbers in the SMNEA has been strongly influenced by the increase of the Itcha-Ilgachuz caribou population over the last 8 years (from 1400 to 2500; $\lambda = 1.075$), which is the largest local population in the SMNEA.

Telkwa local populations. The north-central metapopulation includes the other eight local populations in the SMNEA. In 2002, four local populations were declining, two were stable, four were increasing, and the Currently, Northern Caribou in the NMNEA are distributed within 16 local populations. Metapopulation structure has not yet been assessed for these local populations. In 2002, one local population was declining, seven were stable and the status of eight local populations was unknown. Six local populations have 200 or fewer animals. According to local population risk criteria, 12 local populations are considered Vulnerable and 5 local populations are considered Not At Risk. Little population information is available for many of the Northern Caribou local populations in the NMNEA.

Boreal caribou

The only estimate of Boreal Caribou numbers in British Columbia is 725 (Heard and Vagt 1996). The current estimate is based on that number (Table 7); however, the reliability of this estimate is unknown. Currently, there is no information on metapopulation structure or on population trend. According to COSEWIC criteria, Boreal Caribou in northeastern British Columbia are considered Vulnerable.

Habitat trends

There is little quantitative information on Woodland Caribou habitat trends in British Columbia; however, Woodland Caribou rely on large tracts of older forests where terrestrial and/or arboreal lichens are abundant and where they can use "space" to avoid predators. Industrial activities such as forest harvesting and oil and gas development affect Woodland Caribou habitat through fragmentation and conversion of older forests to early seral stands. The current rate of loss and fragmentation of caribou habitat through forest harvesting, oil and gas development, and natural disturbances (fire and forest insects) appears to be greater than the rate of habitat recruitment.

Threats

Population threats

Threats to Woodland Caribou populations may affect caribou numbers directly through mortality or indirectly through disturbance or displacement resulting in increased energetic costs or mortality risks. Direct threats include predation, hunting, poaching, vehicle collisions, and diseases and parasites. Indirect threats include road development and associated traffic, persistent recreational activities on caribou ranges, and habitat alteration that results in increased mortality risks.

Table 7. Current population estimate (2002), trend, risk status, and density of Boreal Caribou in British Columbia

Local population	Population estimate	Recent trend[a]	Population risk status[b]	Risk criteria[c]	Range[d] (km²)	Density (no./1000 km²)
Boreal Caribou	725	Unknown	VU	A1	51 541	14

a Recent trend defined as trend over last 7 years (1 generation length). Trend based on >20% change.

b At risk status based on Thomas and Gray (2001), draft guidelines for quantitative risk assessment of local populations. EN = Endangered; NAR = Not at Risk; TR = Threatened; VU = Vulnerable.

c Risk criteria (from Thomas and Gray 2001), see Hatter et al. (2002, Appendix 3).

d Current occupied range.

Predation

Woodland Caribou populations in British Columbia exist within dynamic and complex predator–prey systems. Wolves appear to be the most significant predator, but bear predation during early summer contributes significant mortality in some areas. Recent studies (see Seip and Cichowski 1996) have found that predation during the summer can be a major cause of caribou mortality. The increase in moose populations in central British Columbia during the 1900s has been associated with long-term declines in the number of some caribou populations and extirpation of caribou from previously occupied areas (Seip and Cichowski 1996). Increased moose populations may have led to caribou declines because moose can sustain wolf numbers even when caribou number decline. In contrast, in a caribou/wolf system, wolf numbers would decline along with any decline in caribou numbers and allow for a subsequent recovery in caribou numbers (Seip 1992a). The susceptibility of caribou to predation may also be influenced by habitat change as favourable moose browsing conditions in cutblocks result in widespread distribution of moose and wolves. Disturbance to the forest (forest harvesting, fire, etc.), whether human-caused or natural, alters the distribution of early seral habitats. Such disturbance could be detrimental to caribou if it increases their contact with predators associated with other ungulates that use early seral stands, such as deer, elk, and moose. Seip (1992a) suggested that wolf predation can eliminate caribou from areas where the wolf population is sustained by other prey species because there is no negative feedback on the number of wolves as caribou numbers decline. If true, this would mean that wolves could persist on moose as they extirpate local caribou populations.

Within a multiple predator–prey system, it is possible for predator numbers to remain relatively high even if predation (or human harvest) has drastically reduced one of the prey species. Caribou are extremely vulnerable to wolf predation compared with most other ungulates (Seip 1991). Caribou usually occur at much lower densities, have larger home ranges, and do not normally use habitats frequented by moose or deer. They also do not use escape terrain as efficiently as mountain sheep or mountain goats, and they have a low reproductive rate relative to moose or mule deer. Therefore, caribou are usually the most vulnerable species in a multiple predator–prey system, the first to decline and the last to recover (Seip 1991). Seip (1992a) suggested that wolf predation can eliminate caribou from areas where the wolf population is sustained by other prey species, because there is no negative feedback on the number of wolves as caribou decline in numbers. Thus, wolves could persist on moose or deer as they extirpate local caribou populations.

Human-caused mortalities

Aboriginal people who are hunting within their traditional territories may legally hunt caribou. There are no legal hunting seasons on Mountain Caribou or Boreal Caribou in British Columbia for resident or non-resident hunters, but poaching and "mistaken identity" shootings probably remove some animals, as do motor vehicle collisions. The extent of this mortality is unknown, although Johnson (1985) found human-caused deaths in the South Selkirks Mountain Caribou local population to equal recruitment in some years. Legal hunting seasons for resident and non-resident hunters exist for most Northern Caribou local populations in the NMNEA. Hunting regulations are generally conservative with either a five-point bull, Limited Entry Hunt regulation, or a combination of both. Hunting mortality is low for most Northern Caribou local populations in the SMNEA with most of the hunter harvest concentrated in the Itcha-Ilgachuz and Chase local populations. There are no legal hunting seasons for seven of the 13 local populations in the SMNEA (Charlotte Alplands, Rainbows, Telkwa, Takla, Kennedy-Siding, Wolverine, Belcourt) and for one of the 16 local populations in the NMNEA (Mount Edziza). Parts of three Northern Caribou ranges fall within No Hunting areas or Caribou Closed areas (Atlin West, Spatsizi, Tweedsmuir-Entiako).

Diseases and parasites

There do not appear to be any diseases or parasites occurring with enough frequency among Mountain Caribou to pose a significant population-level health risk. Parasites reported by McTaggart-Cowan (1951) from caribou elsewhere in British Columbia or adjacent areas of Alberta include caribou nostril-fly or caribou bot fly (*Cephenemyia trompe* = *C. nasalis* = *Oestrus trompe*), caribou warble (*Hypoderma tarandi* = *Oestrus tarandi* = *Hypoderma tarandi*), thin-necked bladderworm (*Cysticercus tenuicollis*), the tapeworm *Cysticercus krabbei*, and pinworm (*Skrjabinema oreamni*). Other caribou parasites in British Columbia include hydatid cysts (*Echinococcus granulosus*) and the nematode *Parelaphostrongylus odocoilei* (H. Schwantje, pers. comm.). Winter ticks (*Demacentor albipictus*) have been recorded on caribou in Alberta (Samuel 1993) so likely also occur on B.C. caribou. Besnoitia (*Besnoitia tarandi*) is a protozoan that forms cysts in the connective tissue of caribou and other intermediate hosts. It can be fatal (Glover et al. 1990) but rarely is, generally resulting only in dermal damage (H. Schwantje, pers. comm.). This parasite was found in 23% of 320 caribou leg pairs examined from British Columbia, but most of the infections were from the far northern part of the province and few had skin lesions (R. Lewis, pers. comm.). Liver flukes (*Fascioloides magna*) have not been recorded from caribou in British Columbia, but occur in caribou of northern Quebec and other ungulates in British Columbia. The risk of liver flukes occurring in caribou is greater when there is overlap with elk or white-tailed deer (F. Leighton, pers. comm.), so their eventual occurrence in Mountain Caribou can be expected due to increasing range overlap with other ungulates. One of the greatest potential risks to Woodland Caribou from parasites may be the meningeal worm (*Parelaphostrongylus tenuis*) in areas where it occurs. It is a parasite of white-tailed deer throughout eastern North America. The adult worms live in the spaces around the brain in white-tailed deer and rarely cause disease. However, when other cervids, such as caribou, are infected the worms migrate to the central nervous system causing severe, usually fatal, neurological disease. Fortunately the parasite has not been found to date west of the Manitoba-Saskatchewan border.

Population size

Within the 12 smallest local populations (local populations ≤100 caribou: seven Mountain Caribou local populations, five Northern Caribou local populations), the most immediate threat is simply low population size. Low numbers increase the probability that a random event (i.e., one predator, one emigration movement, one avalanche, one extreme weather event, a few key animals poached) will remove a large proportion of the breeding population and also increase the chance of creating an unfavourable sex composition. There are no reliable estimates of the minimum viable population size for Woodland Caribou.

Access/Disturbance

One of the major indirect threats to Woodland Caribou populations is increasing road development and access into their habitat (Bergerud 1978; Johnson 1985; Seip 1991). The resulting threat may take several forms. Improved access to the summer calving range may increase risk of disturbance by humans during calving; calving areas are the most sensitive of all habitats for caribou (Seip and Cichowski 1996) and require protection. Historically, overhunting was primarily a result of road access associated with human industrial and recreational development (Bergerud 1978; Stevenson and Hatler 1985). While the more accessible Woodland Caribou populations are currently not hunted, poaching losses, which are most common along roads during hunting season for other game species, remain a concern. Road kills can also be a concern, such as those that have occurred with the opening of Highway 3 across the range of the South Selkirk Mountain Caribou local population (Johnson 1976; Simpson et al. 1994).

The effects of disturbance of human activities on caribou are more difficult to document and remain controversial. Hauling by logging trucks in Ontario apparently caused Woodland Caribou to move out of the haul road areas that were preferentially used by caribou in the years before and after hauling

(Cumming and Hyer 1998). In Alberta, simulated petroleum exploration noise was also found to increase energy expenditure by Woodland Caribou (Bradshaw et al. 1997). Physical disturbance from such exploration, such as roads, drilling sites, and seismic lines resulted in avoidance of habitats well beyond actual development "footprints" (Dyer et al. 2001).

After noting the absence of studies showing that disturbance limits caribou populations, Bergerud et al. (1984b) concluded that disturbance should not pose a major threat provided sufficient space is available for caribou to escape unwelcome stimuli. They qualified this conclusion by adding that there is likely an upper limit to the tenacity of caribou to withstand disturbance. Eight years later, Harrington and Veitch (1992) demonstrated this upper limit for Woodland Caribou in Labrador where calf survival during both calving and post-calving periods was negatively correlated to the exposure of females to low-altitude jet flyovers. This led the authors to suggest that the greatest effects of disturbance on calf survival occur during critical periods when other stressors are also acting. Research on stress effects of recreation specific to caribou requires further development; however, a recent study in Yellowstone National Park (Creel et al. 2002) documented a significant increase in stress-related hormone levels in elk and wolves during the snowmobile season. For elk, these levels increased in concert with the daily number of snowmobiles. The authors also noted that despite these stress responses, there was no evidence that current levels of snowmobile activity were affecting the population dynamics of either species.

Recreation

Studies such as Harrington and Veitch (1992) add support to a growing concern that excessive levels of recreational activity within caribou winter range may place animals under stress and displace caribou from suitable winter habitats (Stuart-Smith et al. 1996). Mountain Caribou local populations and some or portions of Northern Caribou local populations use subalpine or alpine terrain during winter. In some areas, Mountain Caribou habitat overlap snowmobile use areas; areas of heavy use by snowmobiles may displace caribou into less desirable foraging habitat and where mortality risks (i.e., predation, avalanches) are higher. The creation of trails in an area may also render caribou vulnerable to predators (James and Stuart-Smith 2000). Compacted trails such as those created by snowmobiling and snowshoeing may provide easier travel corridors for wolves into late winter caribou habitats (Bergerud 1996). Dumont (1993) found that hikers in the Gaspésie disrupted normal caribou behaviours, and shifted caribou from preferred areas on the summit to wooded areas with higher predation risk.

The increasing interest in recreational snowmobiling, combined with better access from roads to high-elevation cutblocks and more powerful machines that are able to access Woodland Caribou ranges, is believed to represent a significant threat to many Mountain Caribou local populations and some Northern Caribou local populations currently, and a significant threat to other populations in the future as access increases into their ranges. A recent review of the potential impacts of four winter backcountry recreation activities on Mountain Caribou, including snowmobiling, heli-skiing, snowcat skiing, and backcountry skiing, indicated that snowmobiling has the greatest perceived threat to Mountain Caribou (Simpson and Terry 2000). Although there is no documentation in British Columbia that snowmobiling has permanently displaced caribou off winter ranges, a single occurrence of snowmobile use in alpine habitat in the Tweedsmuir-Entiako caribou winter range displaced radio-collared caribou from that area for the duration of the winter (D. Cichowski, pers. obs.).

Industrial activities

Industrial activities may alter predator–prey relationships and potentially could increase the total predation rate of caribou by:

- producing early seral stages with enhanced understorey shrub and forb production which may increase the abundance of other ungulates or change ungulate distribution within Woodland Caribou habitat; specifically:

- increased shrub production at low elevations may increase ungulate populations (e.g., elk, deer, and moose) which in turn may increase predator populations, leading to more predator–prey encounters with caribou during winter;
- increased forb production at higher elevations may attract elk, moose, and deer into caribou habitat during summer; predators following their prey into these higher elevation areas may come into contact with caribou more frequently, leading to increased predation rates on caribou during summer;
- restricting caribou into mature forest habitat patches which may increase the search efficiency of predators; and/or
- providing easier access, through construction of roads, for predators to travel into caribou habitats and prey on caribou (James and Stuart-Smith 2000).

In addition, all threats identified below under "Habitat threats" are threats to population size and viability. There is little or no evidence that Woodland Caribou can be maintained over the long term in areas having relatively high levels of forestry, predation, and recreation activity.

Habitat threats

One of the main long-term threats to Woodland Caribou habitat is the reduction and fragmentation of contiguous old-growth forest, mainly due to industrial activities such as forest harvesting. Fragmentation of old forest and peatland complexes in Boreal Caribou habitat in northeastern British Columbia by oil and gas development is also a concern. Past fires have also contributed to the loss of habitat over large areas, and there are risks of future large fires. Forest insects are also currently playing a larger role in forest renewal on some Northern Caribou ranges. Habitat loss has several effects:

- It reduces the amount of space available for caribou, thereby limiting ecological carrying capacity.
- Terrestrial and arboreal lichen supply (although currently not limiting) may be reduced. Because lichen regeneration is often slow, impacts on lichen supply are often long term.
- It may impact caribou movement patterns.
- By fragmenting habitat, it may decrease the chance of caribou using some portions of the remaining habitat, because parcels tend to be smaller and discontinuous. Alternatively, if the remaining parcels are used, caribou may expend more energy travelling between patches.
- Caribou can become more susceptible to predation as available habitat is compressed and fragmented (see "Population threats").

Forest harvesting

Forest harvesting has been recognized as the greatest concern to Mountain Caribou habitat management over the past 20 years. Early winter habitat in the ICH has always been attractive for forest harvesting due to good forest productivity on those sites. Late winter ESSF habitat has only recently (last 10 yr) become attractive for forest harvesting. Prior to the 1970s there was little industrial activity on low productivity Northern Caribou low elevation winter ranges in British Columbia. Relatively low-value pine forests and the remote location of most of those winter ranges made them unattractive for forest harvesting. Improved road access, developments in log processing that resulted in better utilization of smaller trees, suitable sites for conducting summer logging (dry pine sites) which are often in short supply, and a growing demand for pulp contributed to increased interest in caribou winter ranges for forest harvesting.

Forest harvesting affects Woodland Caribou winter habitat at both the stand and landscape levels. At the stand level, some harvesting and silvicultural techniques disturb lichens. Because lichen regeneration is slow, forest harvesting has long-term implications for caribou winter habitat. Harvesting techniques that minimize disturbance to lichens may help reduce stand level impacts. Although food supply (lichens) is currently not a limiting factor, cumulative impacts of forest harvesting over time could potentially have long-term impacts on food supply. Caribou require an adequate supply of lichens over the landscape to allow for rotation of winter ranges. Forest fragmentation could potentially result in caribou concentrating on portions of their range, thereby depleting lichen reserves over time.

At the landscape level, forest harvesting results in a patchwork of different forest age classes, which leads to avoidance and possibly abandonment of that portion of the winter range (Smith et al. 2000). Caribou populations persist at low densities due to a number of interacting factors, including predation (Bergerud et al. 1984b; Bergerud and Page 1987). Abandoning a portion of a winter range forces caribou to concentrate in a smaller area, which may lead to increased predator efficiency by making them easier for predators to locate (Seip 1991). A patchwork of early seral and mature forests may also enhance habitat for other prey species such as moose that prefer early seral forests, which could lead to increased predator numbers and increased predation on caribou (Seip 1992a). Potential indirect effects of forest harvesting and habitat fragmentation on caribou populations through increased energetic costs and predation risk are discussed in the "Population threats" section.

Although caribou winter habitat must provide adequate amounts of terrestrial lichen, it is now recognized that food is not the primary limiting factor, and that the distribution of both the summer and winter habitats on the landscape, and the ability of caribou to become spatially separated from predators, particularly during the summer months, are the most important factors to the long-term persistence of Northern Caribou (Seip and Cichowski 1996). Forest harvesting practices that produce a patchwork of different forest age classes linked with a network of roads may contain enough lichens to support a caribou population, but probably will not provide an environment where caribou can effectively avoid predators and poachers. The threat from increasing predation may also be exerted at broader scales, independent of issues of fine-scale habitat changes. Predation risk has probably increased over roughly the past century due both to larger numbers of predators at the regional level and less spatial separation due to habitat fragmentation at the stand or landscape level. Ongoing forest harvesting by conventional means may make this situation more severe.

The ability of caribou to move through fragmented habitats or barriers is not well known. However, Smith et al. (2000) documented that Northern Caribou avoid portions of their winter range that have been fragmented by logging. Large human-caused fire-created openings 10–15 km wide have isolated the Narrow Lake and George Mountain local populations of Mountain Caribou (Simpson et al. 1997; Heard and Vagt 1998). Highways and roads may also limit caribou movements, particularly to female and young caribou moving between seasonal ranges (Simpson et al. 1994). Caribou north of Revelstoke appear unwilling to venture south of the Canadian Pacific Railway tracks and the Trans-Canada Highway, possibly due to the rail and highway corridors or to the dense, second-growth stands (Simpson et al. 1997). However, caribou appear to regularly cross Highway 16, east of Prince George, between the North Cariboo Mountains and the Hart Ranges (D. Heard, pers. comm.), and caribou elsewhere in the world make regular migrations through greatly varied habitat conditions. Even if caribou do cross fragmented habitats, there may be costs associated with increased energy expenditure required to locate isolated foraging patches, as well as increased exposure to human-caused harassment and mortality.

Although little information is available on Boreal Caribou in British Columbia, resource extraction in the form of forestry, petroleum and natural gas exploration and production, mining (coal, peat, and potentially diamonds), and agricultural expansion are all recognized as potentially having negative impacts on Boreal Caribou in Alberta (Dzus 2001).

Natural disturbances

Fire and forest insects are important disturbance factors on many Northern Caribou ranges. Fire suppression has resulted in reduced fire impacts on most woodland caribou ranges in central

British Columbia over the last 40 years, although fire disturbance has likely had greater impacts on caribou ranges in the northern part of the province. Recently, mountain pine beetles have affected a significant portion of the Tweedsmuir-Entiako Northern Caribou range. Although the effects of mountain pine beetles on caribou habitat and winter range use are not known, mountain pine beetles could potentially result in increased or decreased lichen productivity depending on site conditions. A reduction in the forest canopy and consequently snow interception could have implications to caribou movement and foraging during winter. Eventual blowdown of beetle-killed trees could also have implications for caribou movement. Larger mountain pine beetle outbreaks are often managed through increased forest harvesting efforts; extensive salvage logging also occurs soon after beetle attack. Winter ranges not located in protected areas will likely be subjected to increased forest harvesting and salvage if mountain pine beetle outbreaks occur, leading to concerns over the additive effects of mountain pine beetles, forest harvesting for mountain pine beetle management, and salvage logging of mountain pine beetle killed forests on caribou winter ranges.

Climate change

Climage change has the potential to affect Caribou habitat through changes to natural disturbance regimes and vegetation structure which may ultimately lead to changes in lichen abundance.

Legal Protection and Habitat Conservation

All Woodland Caribou in British Columbia are protected from willful killing, wounding, and taking, and legal harvesting is regulated under the provincial *Wildlife Act*. Hunting of Mountain Caribou and Boreal Caribou is prohibited while hunting for 22 of the 29 Northern Caribou local populations is currently permitted.

Protected areas, both provincial and federal, provide habitat protection from industrial activities and unroaded wilderness. Some of the larger protected areas occurring in Woodland Caribou ranges are Wells Gray Provincial Park, Glacier National Park, Tweedsmuir Provincial Park, Itcha-Ilgachuz Provincial Park, Entiako Provincial Park and Protected Area, Spatsizi Plateau Wilderness Provincial Park, Stikine River Provincial Park, and Mount Edziza Provincial Park.

Under the results based code, specific regulations address winter range and mineral licks.

Land use plans (LUP) or land and resource management plans (LRMP) have been developed for all areas where Mountain Caribou and Boreal Caribou regularly occur and for most areas where Northern Caribou occur (see Cichowski 2003). Resource management zone (RMZ) objectives from these have been or are being considered for designation as higher level plans or establishment of legal objectives under the *Land Act*.

Mountain caribou

For Mountain Caribou, each LUP or LRMP requires or allows for:

- zones where there will be no or very limited timber harvest;
- zones where modified timber harvest to maintain habitat values will occur; and
- areas with no special provisions for caribou.

However, guidelines have not been developed according to provincial standards, and the level of habitat protection varies regionally (Table 8). The great majority of recently occupied Mountain Caribou range within the Cariboo-Chilcotin Land Use Plan area is now within (in descending order) provincial parks, no-harvest zones, or modified-harvest zones and the Mountain Caribou Strategy provides specific and detailed guidance on silvicultural systems (Youds et al. 2000). The Prince George and Robson Valley LRMPs have included most of the caribou habitat within interim deferral areas and to a lesser degree, in parks. The Kamloops LRMP area is immediately adjacent to Wells Gray Provincial Park so caribou there have habitat security within Wells Gray and a few new parks, and 20–33% of the caribou zone outside of parks is to be maintained

Table 8. Current approaches to Mountain Caribou habitat management within LRMPs and LUPs

LRMP/LUP	Approach
Cariboo-Chilcotin	No-harvest and modified-harvest zones, each of which is mapped.
Kootenay-Boundary	No-harvest and modified-harvest zones conceptual only. Overall management areas are mapped, but precise locations of zones are not (in progress).
Prince George	No-harvest and modified-harvest zones, each of which is mapped (but no-harvest zones may become available for modified harvest, pending results in areas now designated for modified harvest).
Robson Valley	No-harvest and modified-harvest zones, each of which is mapped (but no-harvest zones may become available for modified harvest, pending results in areas now designated for modified harvest).
Kamloops	Similar to Kootenay/Boundary but based on the retention of old-growth attributes, not old-growth forests per se, and partial cutting is preferred but not required in non-reserve areas.
Okanagan-Shuswap	Identifies OGMAs to be maintained as reserves and also identifies research areas, which may later become reserves, conventional harvest areas, or modified-harvest areas, pending research results.

with old-growth attributes. The Okanagan-Shuswap LRMP allots approximately 20% of the caribou resource management zone to Old-Growth Management Areas (OGMAs) and about 3% to new or existing parks, with a further 20% deferred as research areas. The Kootenay-Boundary Land Use Plan allocates 40–50% of the operable portion of caribou management areas for reserves or modified harvest, and perhaps 10% of the total occupied caribou range is in new or existing provincial and federal parks.

Mountain Caribou have been a major consideration in the designation of OGMAs, but these often overlap with lands that were already, or would otherwise have been, reserved for caribou, so generally do not add additional protection. In the Okanagan-Shuswap LRMP, all permanent caribou reserves are OGMAs. Areas that are currently considered inoperable provide additional habitat for each local population of caribou, but the extent of these is likely to be reduced as technological or economic conditions change.

Access management approaches and (for most plans) guidelines for alternative silvicultural systems are less specific than habitat protection guidelines and are typically not included in higher level plans. Local decisions on alternative silviculture will presumably be guided mainly by the recommendations for managers guidebook (Stevenson et al. 2001). Interim guidelines for access and disturbance management relative to new commercial recreation tenures have been developed (MELP 2000).

A recovery strategy for the entire Mountain Caribou metapopulation has recently been completed (Hatter et al. 2002) and a recovery action plan specific to the South Purcell local population is currently being developed (Kinley 2000). Plans for other local populations may be developed in the future as determined by Regional Action Groups (Hatter et al. 2002). The recovery strategy and proposed recovery action plan for the South Purcell local population do not create any additional legal obligations. However, they do indicate an intent to maintain Mountain Caribou, consistent with the federal-provincial National Accord for the Protection of Species at Risk, and will provide a benchmark from which to measure regional and sub-regional management plans. Several factors influencing caribou population viability that do not fall within the results based code or do so only partially are addressed in recovery plans, including population goals for predators and alternate prey species, and motorized recreation management.

Northern caribou

Current strategies to protect local populations of Northern Caribou and habitat have been mostly developed independently for each population and are reflected in regional land and resource management plans (Chicowski 2003). Although there is no province-wide strategy that guides management direction for all local populations of Northern Caribou, planning efforts have often been coordinated between land use planning processes that share a common caribou winter range. However, core caribou ranges for some local populations, and corridor/linkage areas between local populations still must be mapped and considered in various plans.

Some form of caribou habitat management guideline(s) or planning/operational direction is in place in most MWLAP regions that support Northern Caribou. Currently, an LRMP process is underway for the Morice Forest District which includes portions of three Northern Caribou local populations in the SMNEA (Tweedsmuir-Entiako, Telkwa, Takla) and a Strategic Resource Management Plan is being developed for the Dease/Liard portion of the Bulkley-Cassiar Forest District. Only two areas remain without regional level management plans: the Nass portion of the Kalum Forest District, which includes a small portion of the Spatsizi caribou local population's range; and the Atlin-Taku region of the Bulkley-Cassiar Forest District, which includes four local populations (Atlin West, Atlin East, Jennings, Level-Kawdy).

Prescriptions vary by planning area and local populations of caribou although communication between planning processes has resulted in mostly consistent prescriptions for local populations of caribou whose ranges straddle planning areas. Most plans consist of a combination of protected area or no-harvest zone in portions of each caribou range, with varying degrees of industrial activity within the rest of the range. Although unprotected portions of most caribou ranges have some special management status, large portions of some ranges are located in general resource management zones or even enhanced resource management zones.

In most of the land use plans, caribou and caribou habitat management are a high priority. District-wide Caribou Management Strategies were developed in the Mackenzie, Cassiar-Iskut-Stikine, and Fort St. James LRMPs. In the Lakes, Vanderhoof, and Bulkley LRMPs, caribou management strategies are concentrated within resource management zones that encompass most of the caribou range found in those districts. The Cariboo-Chilcotin Land Use Plan also defines a regional level Northern Caribou Strategy, that provides specific direction on all aspects of caribou management including mountain pine beetle infestations (Youds et al. 2002). The Dawson Creek, Fort St. John, Fort Nelson, and Prince George LRMPs do not contain specific district wide strategies for managing caribou and caribou habitat; instead, caribou management guidelines have been developed for individual resource management zones. However, portions of the Fort St. John, Fort Nelson, and Mackenzie LRMP areas are included within the Muskwa-Kechika Management Area, which includes special provisions for access management and resource extraction. Many of the protected areas established under the *Environmental Land Use Act* within the Muskwa-Kechika Management Area contain provisions for road corridors and most of the area outside of protected areas is under special management.

Although large-scale mountain pine beetle outbreaks have occurred or may potentially occur in most caribou winter ranges in the central part of the province, most of the land use plans provide little guidance for mountain pine beetle management on caribou winter ranges. Potential additive effects of mountain pine beetles, mountain pine beetle management, and salvage logging are of concern.

In general, most Northern Caribou management prescriptions in these plans focus on:

- avoiding critical habitats through no harvesting or special management;
- providing large contiguous areas of mature and old forest;
- conducting harvesting strategies that emulate natural disturbances;

- maintaining forest structure and age classes close to natural disturbance patterns;
- creating large forest harvesting openings and concentrating them in time and space to minimize industrial activity on caribou ranges;
- using forest harvesting and silvicultural systems that enhance retention and recovery of terrestrial lichens; and,
- developing recreation and access management strategies that limit or prohibit recreational activities and access in specific areas during critical seasons.

Boreal caribou

Boreal Caribou range in British Columbia falls within two forest districts with completed LRMPs: the Fort Nelson LRMP and the Fort St. John LRMP. There are no district-wide caribou management strategies and strategies for Boreal Caribou are primarily contained in individual resource management zones. In the Fort Nelson LRMP, most of the Boreal Caribou range is in enhanced resource development zones with the southwestern portion in general resource development zones; provisions for caribou are included under general provisions for wildlife. In the Fort St. John LRMP, most of the Boreal Caribou range is in general management zones with a small portion in enhanced resource development, and the southern portion in the agriculture/settlement zone. Provisions for caribou vary between resource management zones with some zones with caribou-specific provisions and others with general wildlife provisions. Lack of management strategies specifically for Boreal Caribou is likely partially due to the lack of knowledge about this ecotype in British Columbia.

Identified Wildlife Provisions

Sustainable resource management and planning recommendations

A conservation assessment should be conducted for Woodland Caribou metapopulations to determine the relative risk to long-term persistence of each metapopulation and ecotype based on current management guidelines, and also on a range of potentially more or less stringent guidelines.

LRMPs and LUPs provide a suitable scale of management for Woodland Caribou because individual caribou are wide-ranging and use a variety of sites within and between years, yet each local population occurs within a reasonably well-defined geographic and habitat range. Furthermore, regional differences in Woodland Caribou ecology and in forest harvesting history indicate that detailed management direction is best provided through a series of regional plans than through a single provincial plan. However, broad approaches are best standardized at a provincial scale to ensure better understanding of the purpose of areas given special designation for caribou, and to ensure that all regional plans meet the basic requirements of Woodland Caribou. The following recommendations should be considered when existing higher level plans are periodically reviewed and revised.

- ❖ Conduct local conservation assessments (including risk assessments) for the local population or area under consideration. The assessment should consider risks to the individual local population and the metapopulation based on current guidelines, and therefore determine the relative need for no-harvest relative to modified-harvest and conventional-harvest zones, and effects of resource exploration activities.
- ❖ Identify areas that should be designated as no-harvest zones, where there will be no or very limited harvest, and/or modified-harvest zones, where partial cutting that maintains habitat values may occur. Within the no-harvest zones, include inoperable areas that are suitable for caribou, in addition to appropriate operable areas.
- ❖ Map the final boundaries of no-harvest zones or modified-harvest zones at 1:20 000.
- ❖ For Mountain Caribou, where plans currently advocate or permit the use of extended-rotation clearcuts (typically 240 yr), either via conventional blocks or strip harvesting, consider a shift to a mix of permanent no-harvest zones and conventional harvest (no caribou constraint) zones, and formalize this as an option in the

plans. The percentage of the plan area potentially shifted from long-rotation to no-harvest should be calculated on the basis of modelling long-term timber production reductions that would otherwise result from the extended rotation. The advantages of smaller permanent no-harvest zones versus larger areas on extended rotations would be:

- no new economic impact relative to existing extended rotation assumptions, yet retention of a large portion of the planning area as caribou habitat;
- a greater assurance that designated habitat would in fact provide suitable habitat because it would be of natural origin and older age, rather than originating as a plantation with a maximum age of 160–240 years;
- fewer roads and off-road access points;
- long-term spatial certainty regarding the areas that would provide caribou habitat, which would simplify planning and allow caribou to develop traditions of use; and
- overlapping of benefits to other obligates of very old forests.

The disadvantage is that less gross area would be managed for caribou. This option should also be considered in cases where long-rotation group- or single-tree selection is currently planned, although there are likely to be fewer benefits in changing to the mixed no-harvest/conventional harvest scenario in such instances. For plans that currently recommend the use of clearcut harvesting with moderate block sizes (~1–40 ha), consider a shift to guidelines requiring partial cutting through single-tree selection or group selection or, as a secondary option, a mix of very large cutblocks and very large reserves as outlined in Stevenson et al. (2001). This will reduce the degree of landscape fragmentation relative to an equivalent area of moderate-sized clearcut blocks, and should therefore reduce the enhancement of habitat for other ungulates and allow caribou to separate themselves from predators.

- For plans in which habitat-influenced predation risk is not explicitly identified as an issue relative to forest harvesting, it should be added to revised versions of the plans.
- Revise existing guidelines for movement routes based on new research. Add guidelines to plans currently lacking them. As research indicates differences in habitat requirements for providing long-term genetic connectivity between local populations versus regular local intra- or interseasonal movement, modify plans to ensure that the terminology and guidelines are appropriate for the type of movement intended to be facilitated.
- Revise access management guidelines based on new research. Add access guidelines to plans currently lacking them. Do not create new roads or upgrade existing roads in areas where forests have been reserved as caribou habitat. To the extent possible, deactivate or close existing roads in areas reserved or managed for caribou when the roads are no longer required for industrial activities. Guidelines for the management of both commercial and non-commercial mechanized backcountry recreation should be adopted, based on the interim management guidelines recommended by Simpson and Terry (2000).
- Ensure a mechanism is included to allow the boundaries or locations of no-harvest and modified-harvest zones to be modified as additional information becomes available about caribou distribution, habitat use, risks associated with various management options, and requirements for long-term viability. This mechanism should also allow boundary changes necessary for the recovery of currently depressed local populations, including augmentation with additional animals or the establishment of new bands of caribou.

Wildlife habitat area

Goal

To temporarily secure critical Woodland Caribou habitat features that have not been yet been addressed through strategic or landscape level planning. As existing plans are amended or developed, WHAs established for Woodland Caribou should be considered for inclusion within legal objectives of the revised plans or new plans.

Feature

Establish WHAs at mineral licks, rutting or calving sites (if used repeatedly), and small areas of "matrix" habitat necessary for connectivity between winter foraging areas (if used repeatedly). Preferably, WHAs should be established in areas of suitable caribou habitat where:

- no-harvest zones and modified-harvest zones are not sufficiently large to maintain or restore viable caribou local populations as indicated by a conservation assessment; or
- there is a high level of uncertainty that this is the case; or
- critical habitat features not addressed within an existing regional or sub-regional plans are determined to be of high value or high use.

WHAs designated under the provincial timber supply impact limit (1% by district) for the Identified Wildlife Management Strategy will only be established within threatened or endangered local populations, except for sites where there is no timber supply impact or the site is considered provincially significant and approved by the Director of the Biodiversity Branch, B.C. Ministry of Water, Land and Air Protection. Normally, WHAs will only be established to protect critical habitat features deemed important to the long-term persistence of the local population.

For matrix habitat connectivity, WHAs should be located immediately adjacent to protected areas or areas designated under strategic land use plans for caribou management.

Size

Larger WHAs will almost always be of greater benefit to caribou than smaller WHAs, primarily because increased size improves the ability of caribou to avoid predation. When WHAs are established in matrix habitat for connectivity, they should be roughly 100–1000 ha. In most cases, calving sites, rutting areas, and mineral licks may be adequately managed in areas of 50–300 ha. For calving sites on islands, the entire island should be considered for inclusion within a WHA. The appropriate size for a WHA will be determined in part by whether it is possible to link to existing habitat and the degree of disturbance that is expected adjacent to the WHA.

Design

Design WHA to minimize the amount of edge, and consider habitat use and the needs of the local population. The size of the area included within the WHA to reduce disturbance will depend on topographic barriers and vegetative cover.

General wildlife measures

Goals

1. Minimize predation risk.
2. Maintain critical habitat features (e.g., mineral lick, undisturbed travel corridor or calving or rutting areas).
3. Minimize disturbance.

Measures

Access

- Do not construct roads or trails.

Harvesting and silviculture

- Do not harvest WHAs established for mineral licks, rutting, and calving sites. For matrix habitat, develop a management plan that is consistent with the general wildlife measures goals.

Pesticides

- Do not use pesticides.

Recreation

- Do not develop recreation sites or trails.

Additional Management Considerations

Guidelines for the management of both commercial and non-commercial mechanized backcountry recreation should be adopted, based on the interim management guidelines recommended by Simpson and Terry (2000). (See MWLAP Web site at http://wlapwww.gov.bc.ca.)

In addition to reducing the effect of predation through forest management that minimizes fragmentation and habitat creation for other ungulates, large mammal species should be managed with the goal of locally reducing the number of other ungulates and associated predators, where such species were historically rare or absent.

If motor vehicle collisions (Highways 3, 5, and 16, Alaska Highway) are identified as a significant source of mortality in some local populations, and kill locations and timing are consistent, seasonal speed zones should be instituted.

Information Needs

1. Metapopulation conservation assessment/risk analysis relative to a range of management options.
2. Long-term suitability of areas cut through modified harvest to support caribou, with reference to both forage and predation risk.
3. Relative contribution to predation of regional increases in alternate prey numbers versus stand level or landscape level habitat fragmentation.

References Cited

Apps, C.D. and T.A. Kinley. 2000a. Mountain caribou habitat use, movements, and factors associated with GPS location bias in the Robson Valley, British Columbia. Columbia Basin Fish and Wildl. Compensation Program, Nelson, B.C., and B.C. Environ., Prince George, B.C.

_____. 2000b. Multi-scale habitat associations of mountain caribou in the southern Purcell Mountains, British Columbia. East Kootenay Environ. Soc., Kimberley, B.C., and Tembec Industries Inc., Cranbrook, B.C.

_____. 2000c. Multiscale habitat modeling for mountain caribou in the Columbia Highlands and Northern Columbia Mountains ecoregions, British Columbia. B.C. Min. Environ., Lands and Parks, Williams Lake, B.C.

Apps, C.D., B.N. McLellan, T.A. Kinley, and J. Flaa. 2001. Scale-dependent habitat selection by mountain caribou in the Columbia Mountains, British Columbia. J. Wildl. Manage. 65:65–77.

Banfield, A.W.F. 1961. A revision of the reindeer and caribou, genus *Rangifer*. Natl. Mus. Can., Ottawa, Ont. Bull. No. 177, Biol. Ser. 66.

Bergerud, A.T. 1974. The decline of caribou in North America following settlement. J. Wild. Manage. 38:757–770.

_____. 1978. The status and management of caribou in British Columbia. B.C. Fish and Wildl. Br., Victoria, B.C.

_____. 1980. A review of the population dynamics of caribou and wild reindeer in North America. *In* Proc. 2nd Int. Reindeer/Caribou Symp. E. Reimers, E. Gaare, and S. Skjennebeg (editors). Roros, Norway, 1979, pp. 556–581.

_____. 1992. Rareness as an antipredator strategy to reduce predation risk for moose and caribou. *In* Wildlife 2001: populations. D.R. McCullough and R.H. Barrett (editors). Elsevier Applied Sci., New York, N.Y., pp. 1008–1021.

Bergerud, A.T. 1996. Evolving perspectives on caribou population dynamics, have we got it right yet? Rangifer Spec. Issue No. 9:95–116.

Bergerud, A.T. and R.E. Page. 1987. Displacement and dispersion of parturient caribou at calving as antipredator tactics. Can. J. Zool. 65:1597–1606.

Bergerud, A.T., H.E. Butler, and D.R. Miller. 1984a. Antipredator tactics of calving caribou: dispersion in mountains. Can. J. Zool. 62:1566–1575.

Bergerud, A.T., R.D. Jakimchuck, and D.R. Carruthers. 1984b. The buffalo of the north: caribou (*Rangifer tarandus*) and human developments. Arctic 37:7–22.

Bradshaw, C.A., S. Boutin, and D.M. Hebert. 1997. Effects of petroleum exploration on woodland caribou in northeastern Alberta. J. Wildl. Manage. 61:1127–1133.

B.C. Ministry of Environment, Lands and Parks (MELP). 2000. Expanded Kootenay Region interim wildlife guidelines for commercial backcountry recreation in British Columbia. Wildl. Br., Victoria, B.C.

Cichowski, D.B. 1993. Seasonal movements, habitat use, and winter feeding ecology of woodland caribou in west-central British Columbia. B.C. Min. For., Victoria, B.C. Land Manage. Handb. No. 79. 54 p.

Committee on the Status of Endangered Wildlife in Canada (COSEWIC). 2002. Canadian species at risk. Available from: http://www.speciesatrisk.gc.ca

Creel, S., J.E. Fox, A. Hardy, J. Sands, B. Garrot, and R.O. Peterson. 2002. Snowmobile activity and glucocorticoid stress responses in wolves and elk. Conserv. Biol. 16:809–814.

Cumming, H.G. and B.T. Hyer. 1998. Experimental log hauling through a traditional caribou wintering area. Rangifer Spec. Issue No. 10:241–258.

Demarchi, D.N. 1999. Population trends of the big game species in British Columbia. Review draft. B.C. Wildl. Fed. and B.C. Conserv. Found. *Note: This report is in draft form and the sponsoring organizations wish to state that its findings do not necessarily represent the views of the BCWF or BCCF.*

Dumont, A. 1993. The impact of hikers on caribou (*Rangifer tarandus caribou*) of the Gaspésie Conservation Park. thesis. Laval Univ., Quebec City, Que. (Translated from French.)

Dyer, S J. 1999. Movement and distribution of woodland caribou (*Rangifer tarandus caribou*) in response to industrial development in northeastern Alberta. MSc. thesis, Dept. Biol. Sci., Univ. Alberta, Edmonton, Alta. 109 pp.

Dyer, S.J., J.P. O'Neill, S.M. Wasel, and S. Boutin. 2001. Avoidance of industrial development by woodland caribou. J. Wildl. Manage. 65:531–542.

Dzus, E. 2001. Status of the Woodland Caribou (*Rangifer tarandus caribou*) in Alberta. Alberta Environ., Fisheries and Wildl. Manage. Div., and Alberta Conserv. Assoc. Edmonton, Alta. Wildl. Status Rep. No. 30. 47 p.

Edmonds, E.J. 1988. Population status, distribution, and movements of Woodland Caribou in west central Alberta. Can. J. Zool. 66:817–826.

_____. 1991. Status of woodland caribou in western North America. Rangifer Spec. Issue No. 7:91–107.

Glover, G.J., M. Swendrowski, and R.J. Cawthorn. 1990. An epizootic of besnoitiosis in captive caribou (*Rangifer tarandus caribou*), reindeer (*Rangifer tarandus tarandus*) and mule deer (*Odocoileus hemionus hemionus*). J. Wildl. Dis. 26:186–195.

Harrington, F.H. and A.M. Veitch. 1992. Calving success of woodland caribou exposed to low-level jet overflights. Arctic 45:213–218.

Hatler, D.F. 1986. Studies of radio-collared caribou in the Spatsizi Wilderness Park area, British Columbia. Spatsizi Assoc. For Biol. Res. Rep. No. 3. 202 p.

Hatter, I., D. Butler, A. Fontana, D. Hebert, T. Kinley, S. McNay, B. Nyberg, D. Seip, J. Surgenor, M. Tanner, L. Williams, G. Woods, J. Woods, and J. Young. 2002. A strategy for the recovery of Mountain Caribou in British Columbia. Version 1.0. Mountain Caribou Tech. Advisory Comm., Victoria, B.C. 73 p.

Heard, D.C. and K.L. Vagt. 1998. Caribou in British Columbia: a 1996 status report. Rangifer Spec. Issue 10:117–123.

Hornbeck, G.E. and D.L.J. Moyles. 1995. Ecological aspects of Woodland Caribou in the Pedigree area of northwestern Alberta. Members of the Pedigree Caribou Standing Committee, Calgary, Alta. 66 p.

James, A.R.C. and A.K. Stuart Smith. 2000. Distribution of caribou and wolves in relation to linear corridors. J. Wildl. Manage. 64:154–159.

Johnson, C.J., K.L. Parker, D.C. Heard, and M.P. Gillingham. 2002. A multiscale behavioural approach to understanding caribou the movements of woodland caribou. Ecol. Appl 12(6):1840–1860.

Johnson, D.R. 1976. Mountain caribou: threats to survival in the Kootenay Pass Region, British Columbia. Northwest Sci. 50:97–101.

_____. 1985. Man-caused deaths of mountain caribou, *Rangifer tarandus*, in southeastern British Columbia. Can. Field-Nat. 99:542–544.

Kinley, T.A. 2000. Recovery Action Plan for the south Purcell subpopulation of mountain caribou. Draft. B.C. Min. Environ., Lands and Parks, Victoria, B.C., Tembec Industries Inc., Cranbrook, B.C., and East Kootenay Environ. Soc., Kimberley, B.C.

Kinley, T.A. and C.D. Apps. 2001. Mortality patterns in a subpopulation of endangered mountain caribou. Wildl. Soc. Bull. 29:158–164.

McTaggart-Cowan, I. 1951. The diseases and parasites of big game mammals of western Canada. *In* Proc. 5th Ann. Game Convention, pp. 37–64. Reprinted by B.C. Min. Environ. and Parks, Victoria, B.C., in 1988.

Poole, K.G., D.C. Heard, and G. Mowat. 2000. Habitat use by woodland caribou near Takla Lake in central British Columbia. Can. J. Zool. 78:1552–1561.

Rominger, E.M., C.T. Robbins, and M.A. Evans. 1996. Winter foraging ecology of woodland caribou in northeastern Washington. J. Wildl. Manage. 60:719–728.

Rominger, E.M., C.T. Robbins, M.A. Evans, and D.J. Pierce. 2000. Autumn foraging dynamics of woodland caribou in experimentally manipulated habitats, northeastern Washington, USA. J. Wildl. Manage. 64:160–167.

Samuel, W.M. 1993. Parasites and disease. *In* Hoofed mammals of Alberta. J.B. Stelfox (editor). Lone Pine Publishing, Edmonton, Alta., pp. 81–90.

Seip, D.R. 1991. Predation and caribou populations. Rangifer Spec. Issue No. 7:46–52.

_____. 1992a. Factor limiting woodland caribou population and their interrelationships with wolves and moose in southeastern British Columbia. Can. J. Zool. 70:1494–1503.

Seip, D.R. and D.B. Cichowski. 1996. Population ecology of caribou in British Columbia. Rangifer Spec. Issue No. 9:73–80.

Shoesmith, M.W. and D.R. Storey. 1977. Movements and associated behaviour of woodland caribou in central Manitoba. Proc. Int. Congr. Game Biol. 13:51–64.

Simpson, K. and E. Terry. 2000. Impacts of backcountry recreation activities on mountain caribou. B.C. Min. Environ., Lands and Parks, Wildl. Br., Victoria, B.C. WR-99.

Simpson, K., E. Terry, and D. Hamilton. 1997. Toward a mountain caribou management strategy for British Columbia – habitat requirements and sub-population status. B.C. Min. Environ., Lands and Parks, Victoria, B.C. WR-90.

Simpson, K., J.P. Kelsall, and M. Leung. 1994. Integrated management of mountain caribou and forestry in southern British Columbia. Report to B.C. Min. Environ., Lands and Parks, Victoria, B.C. 106 p.

Smith, K.G., E.J. Ficht, D. Hobson, T.C. Sorensen, and D. Hervieux. 2000. Winter distribution of woodland caribou in relation to clear-cut logging in west-central Alberta. Can. J. Zool. 78:1433–1440.

Stevenson, S.K., H.M. Armleder, M.J. Jull, D.G. King, B.N. McLellan, and D.S. Coxson. 2001. Mountain caribou in managed forests: recommendations for managers. 2nd ed. B.C. Min. Environ., Lands and Parks., Victoria, B.C. Wildl. Rep. R-26.

Stevenson, S.K. and D.F. Hatler. 1985. Woodland caribou and their habitat in southern and central British Columbia. Vols. I and II. B.C. Min. For., Res. Br., Victoria, B.C. Land Manage. Rep. No. 23.

Stuart-Smith, A.K., C. Bradshaw, S. Boutin, D. Hebert, and A.B. Rippin. 1997. Woodland caribou relative to landscape patterns in northeastern Alberta. J. Wildl. Manage. 61(3):622–633.

Stuart-Smith, A.K., D. Hebert, J. Edmonds, and D. Hervieux. 1996. Limiting factors for woodland caribou in Alberta. *In* Alberta's Woodland Caribou Conservation Strategy, Appendix 1, pp. 31–48.

Terry, E.L. and M.D. Wood. 1999. Seasonal movements and habitat selection by woodland caribou in the Wolverine herd, north-central British Columbia. Phase 2: 1994-1997. Peace/Williston Fish and Wildlife Compensation Program Rep. No. 204. 36 p. + appendices.

Thomas, D.C. and D.R. Gray. 2001. Updated COSEWIC status report on "Forest-Dwelling" Woodland Caribou *Rangifer tarandus caribou*. Draft. 115 p.

Wood, M.D. and E.L. Terry. 1999. Seasonal movement and habitat selection by woodland caribou in the Omineca Mountains, north-central British Columbia. Phase 1: The Chase and Wolverine herds (1991-1994). Peace/Williston Fish and Wildlife Compensation Program Rep. No. 201. 35 p. + appendices.

Youds, J., J. Young, H. Armleder, M. Folkema, M. Pelchat, R. Hoffos, C. Bauditz, and M. Lloyd. 2000. Cariboo-Chilcotin Land Use Plan Mountain Caribou Strategy. Cariboo Mid-Coast Interagency Management Committee Special Report. B.C. Min. Water, Land and Air Prot., Williams Lake, B.C. 77 p.

_____. 2002. Cariboo-Chilcotin Land Use Plan Northern Caribou Strategy. Cariboo-Mid-Coast Interagency Management Committee Special Report. B.C. Min. Water, Land and Air Prot., Williams Lake, B.C. 84 p.

Personal Communications

Braumandl, T. 2001. Min. For., Nelson, B.C.

Heard, D. 2001. Min. Water, Land and Air Protection, Prince George, B.C.

Lewis, R. 2001. Min. Agric., Abbotsford, B.C.

Leighton, F. 2001. Univ. of Saskatchewan, Saskatoon, Sask.

Schwantje, H. 2001. Min. Water, Land and Air Protection, Victoria, B.C.

FRINGED MYOTIS

Myotis thysanodes

Original[1] prepared by Mike Sarell

Species Information

Taxonomy

The *Myotis* are the most widespread and diverse genus of vespertilionids in the world. They represent nine of the 16 bat species documented for British Columbia. Three subspecies of Fringed Bats are recognized. British Columbia's population (*M. thysanodes thysanodes*) belongs to the subspecies with the largest distribution (van Zyll de Jong 1985). There is a possibility that the Oregon coast subspecies (*M. thysanodes vespertinus*) may extend into southwestern British Columbia (Nagorsen and Brigham 1993) but there are no records to confirm.

Description

The Fringed Myotis is larger than most others in its genus in British Columbia, except for the Long-legged (*M. volans*) and Western Long-eared (*M. evotis*). They have a wingspan of about 28 cm and a forearm length of 42 mm (Nagorsen and Brigham 1993). The colouring of the dorsal fir is a tan brown, making it lighter coloured than many other Myotis species in British Columbia. The fringe of hairs on the outer edge of the tail membrane can be seen with the unaided eye and is a distinguishing feature of this species.

Distribution

Global

The Fringed Myotis occurs widely across western North America from southern British Columbia to Veracruz and Chiapas in Mexico (Nagorsen and Brigham 1993), with isolated populations in the Black Hills and southeastern Wyoming, South Dakota, and western Nebraska (O'Farrell and Studier 1980) and coastal Oregon (Orr 1956).

British Columbia

In British Columbia, the Fringed Myotis appears to be restricted to the dry interior. Most records are from intensive surveys in the south Okanagan (Collard 1991; Holroyd et al. 1994; Sarell and Haney 2000), but recent captures have extended their range to the Squilax area of the Shuswap (Milligan 1993), other parts of the Thompson (Firman 1994; Firman et al. 1995), the Kettle Valley (Sarell et al. 1997), and into the Cariboo up the Chilcotin River (Roberts and Roberts 1992) at Alkali Lake (Roberts and Roberts 1992; Holroyd et al. 1994). This bat may occur in other suitable areas in the dry interior of the province (e.g., Nicola, Lillooet, West Kootenays), but these areas have been less intensively inventoried.

Forest region and districts

Southern Interior: 100 Mile House, Arrow Boundary, Cascades, Central Cariboo, Chilcotin, Kamloops, Okanagan Shuswap

Ecoprovinces and ecosections

CEI: CAB(?), CHP(?[2]), FRB
SIM: SFH(?)
SOI: GUU, NIB, NOB, NOH, OKR, PAR(?), SHB, SOB, SOH, STU, THB

Biogeoclimatic units

BG: xh1, xh2, xh3, xw, xw1, xw2
ICH(?): dw(?), mw2(?), xw(?)
IDF: dk1(?), dk2(?), dk3(?), dk4(?), dm1(?), mw2(?), xh1, xh1a, xh1b, xh2, xh2a, xh2b, xm, xw
PP: dh1, dh2, xh1, xh2

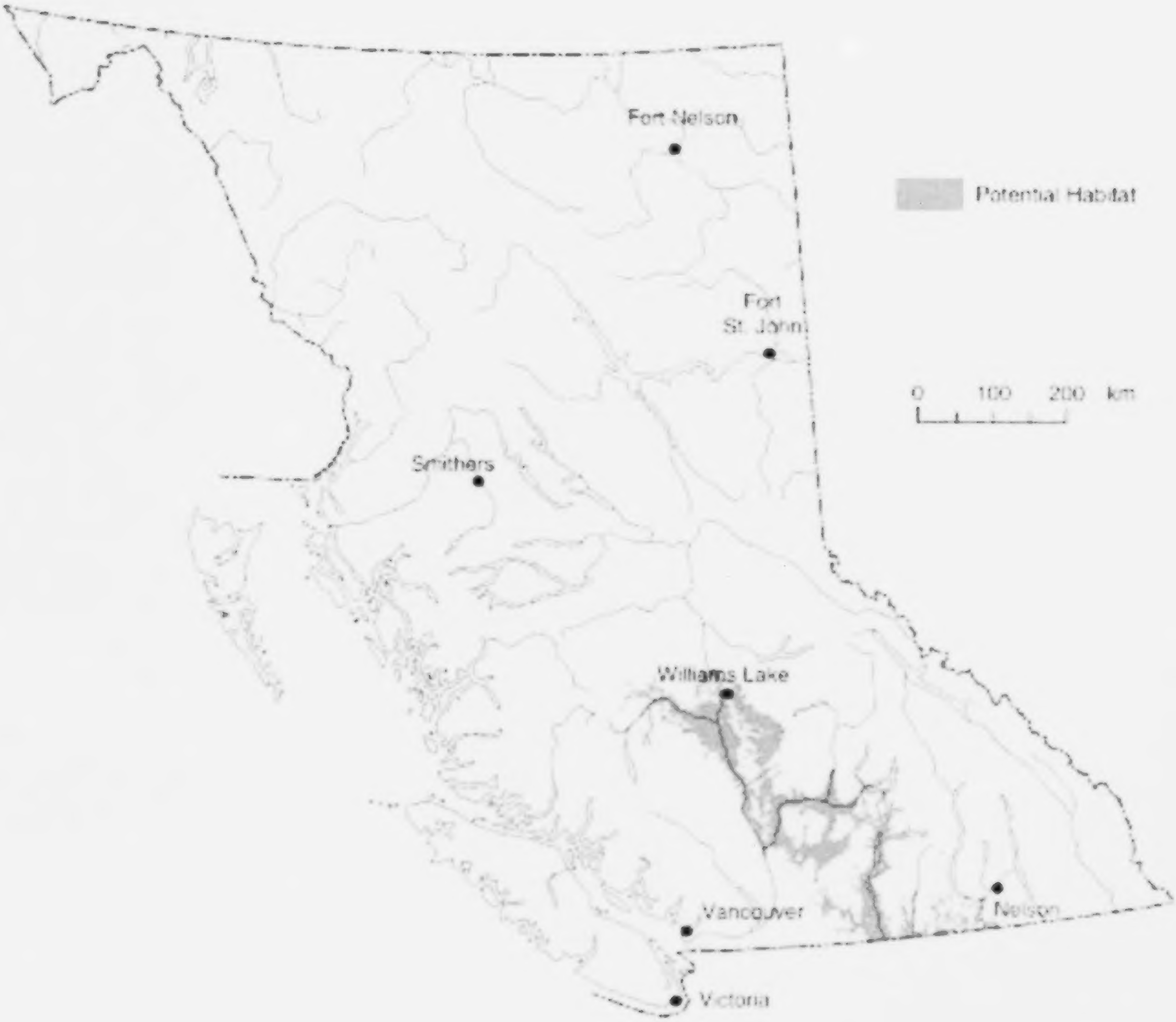
---

[1] Draft account for Volume 1 prepared by S. Rasheed.

[2] (?) Indicates that the range extent has not been determined.

Fringed Myotis

(Myotis thysanodes)


Fort Nelson
Fort St. John
Smithers
Williams Lake
Vancouver
Victoria
Nelson
Potential Habitat
0 100 200 km

Note: This map represents a broad view of the distribution of potential habitat used by this species. The map is based on several ecosystem classifications (Ecoregion, Biogeoclimatic and Broad Ecosystem Inventory) as well as current knowledge of the species' habitat preferences. This species may or may not occur in all areas indicated.

Broad ecosystem units

Roosting: CL, DP(?), RO, PP(?)

Foraging: AB, AC, BS, CF, CR, DF, DP, LS, ME, OV, PP, RO, SP, SS, WL

Elevation

Fringed Myotis are usually captured between 300 and 854 m in British Columbia (Nagorsen and Brigham 1993). The capture reported for an elevation of 1400 m near Squilax (Milligan 1993) was actually ~380 m.

Life History

Diet and foraging behaviour

Little is known of the foraging behaviour of these bats. They are often caught near watercourses and tend to fly close to the canopy (Rasheed et al. 1995), as well as in open grassland habitats. Maternity colonies have been discovered in rural/agricultural settings in British Columbia, and although foraging behaviours were not determined, extensive orchards surrounding the roosts may have been used as foraging habitat. The possibility of varied forging habitat preferences is reflected in their diverse diet of beetles (Black 1974), moths, leafhoppers, harvestmen, and crickets (Whitaker et al. 1977), and lacewings and flies (Nagorsen and Brigham 1993). Many of these insects are fully terrestrial, suggesting that gleaning is employed as a predatory technique. One hypothesis is that the "fringe" is used to strip insects from vegetation. The likelihood that they glean their prey is also supported by their slow and manoeuvrable flight and their wings have high puncture strength, typical of other gleaning bat species that could otherwise tear wings against branches and thorns (O'Farrell and Studier 1980).

Reproduction

Copulation is thought to occur in the fall, and fertilization delayed until spring (O'Farrell and Studier 1980). Adult females form maternity colonies, numbering up to 300 in parts of their range (Rasheed et al. 1995), although both colonies observed in British Columbia were <40 (Maslin 1938; Sarell, unpubl. obs.). These two colonies were in attics of occupied houses although two other maternity colonies are suspected to occur in small cliffs (Sarell and Haney 2000). Typically, a single young is born each year, presumably in early July (Nagorsen and Brigham 1993). The low birth rate is offset by the longevity of this bat, recorded to live up to 18 years (Tuttle and Stevenson 1982).

Site fidelity

Site fidelity to roosts has been demonstrated to be high. A Fringed Myotis was captured at the same mine near Oliver 8 years after being banded (Nagorsen and Brigham 1993). Two maternity roosts in buildings have been identified in the province, and they all showed long periods of occupations (Maslin 1938; Sarell, unpubl. obs.).

Home range

There is no information on the home range of the Fringed Myotis throughout its range.

Movements and dispersal

Anecdotal evidence suggests that in the southern portion of this species' range, they travel short distances from summer to wintering ranges (Studier and O'Farrell 1972). Spring return to maternity colonies is rapid and synchronous. As well, parturition occurs within a narrow timespan, suggesting that the individuals are behaving synchronously for much of the year (O'Farrell and Studier 1976). There have been no observations made of seasonal movements or dispersal in British Columbia.

Habitat

Structural stage

Structural stage may be an important factor in foraging habitats but there have been no studies to document this. Foraging and roosting habitats often are found in interior dry forests (Nagorsen and Brigham 1993).

Important habitats and habitat features

Roosting

Caves, rock crevices, mine tunnels, and buildings have been well documented as providing day, night, and maternity roosts. Because this species roosts in colonies, suitable roosts may need to accommodate a number of individuals. It was recently discovered that Fringed Myotis in Arizona also form maternity roosts under loose bark in ponderosa pine (*Pinus ponderosa*) snags (Rabe et al. 1998). The wildlife tree classification would be described as class 4. Roosting in trees has not yet been documented in British Columbia. Maternity roosts typically have warm aspects, presumably to facilitate the thermoregulatory needs of pups and females.

The winter ecology of this species is poorly known throughout its range, although late summer fat accumulation in places other than British Columbia suggests that these bats hibernate (Ewing et al. 1970; O'Farrell and Studier 1980). The only observations of hibernation have been in caves, consisting of a few individuals in the Black Hills of South Dakota and of solitary individuals in Oregon (Martin and Hawkes 1972; Rasheed et al. 1995). There are no winter records for this species in British Columbia (Nagorsen et al. 1993).

Foraging

The Fringed Myotis occurs in a variety of habitats including mid-elevation grasslands, deserts, and woodlands. In British Columbia, this species is most closely associated with arid grassland and Ponderosa Pine–Douglas-fir (*Pseudotsuga menziesii*) forest (Rasheed et al. 1995). Fringed Myotis are reputed to have strong preferences for foraging over watercourses and close to the vegetative canopy, primarily in ponderosa pine and Douglas-fir forests (Rasheed et al. 1995). However, Fringed Myotis also are captured in grassland habitats (Williams 1968; O'Farrell and Studier 1980; Sarell and Haney 2000). These observations were always within an hour's flight of forested habitat (O'Farrell and Studier 1980). This apparent preference may be an artefact of surveyor preference for trapping where bats are most abundant (e.g., wetlands) and due to low capture rates in open landscapes. Foraging also may occur in orchards where roosts are provided (Maslin 1938; Sarell, unpubl. obs.) but this needs direct testing. There is some evidence of higher activity in old growth and mature stands (age class 5–9; stage 6–7) in Oregon (Thomas and West 1991).

Conservation and Management

Status

The Fringed Myotis is on the provincial *Blue List* in British Columbia (CDC 2002). In Canada, it is designated as a species of *Special Concern* (COSEWIC 2002).

Summary of status in British Columbia and adjacent jurisdictions (NatureServe Explorer 2002)

BC	ID	MT	WA	Canada	Global
S2S3	S1?	S3	S3?	N2N3	G4G5

Trends

Population trends

There have been few studies on population trends of Fringed Myotis throughout their range. In the 1960s, populations in the United States appeared to be quite stable (O'Farrell and Studier 1980). Populations are probably most vulnerable at maternity colonies and at hibernacula. Population trends have not been studied in British Columbia.

Habitat trends

Loss of habitat has been rapid and extensive throughout much of the Fringed Myotis' range in British Columbia. The habitats most prone to development are in the Okanagan and the least prone are in the Cariboo. The impacts of veteran tree and snag removal from forests may have a significant impact throughout their range in British Columbia, but this cannot be determined for certain until it is known how dependent Fringed Myotis are on tree roosts.

Threats

Population threats

Maternity colonies may be prone to disturbance, although abandonment has not been documented (O'Farrell and Studier 1980). Furthermore, maternity colonies could be readily disrupted if the roost structure is destroyed. Colonies in rock crevice roosts are susceptible to destruction through road construction and other activities requiring blasting. It is not known whether recreation activities, such as rock climbing or spelunking, may disrupt colonies, causing mortality, especially to young. No studies have examined the effects of pesticides on population performance.

Habitat threats

Urbanization, road construction, and possibly logging of old growth and/or the removal of snags may be some of the greatest threats to Fringed Myotis habitat. The eradication or exclusion of bats from attics also may be significantly impacting habitat availability. Roosts in caves, mines, and fractures are susceptible to modifications to accommodate recreation and to destruction from road construction and quarrying. Livestock excrement may contaminate surface water to the extent that it becomes unusable or unhealthy.

Legal Protection and Habitat Conservation

The Fringed Myotis is protected, in that it cannot be killed, collected, or held in captivity without special permits, under the provincial *Wildlife Act*.

There are no known roosts within conservation holdings, although two are suspected to be on lands controlled by the Canadian Wildlife Service and The Nature Trust of BC.

Identified Wildlife Provisions

Sustainable resource management and planning recommendations

- Provide adequate representation of foraging and roosting habitat in the landscape by either establishing WHAs when necessary or applying forest practices to ensure habitat representation.
- Maintain a variety of seral stages to ensure long-term provisions of foraging and roost requirements.

Wildlife habitat area

Goal

Maintain roosting, hibernating, or breeding sites.

Feature

Establish WHAs at known hibernacula and maternity roosts. Locating these features may be difficult without conducting radio-telemetry so areas with multiple individuals near suitable roosting features can also be designated as WHAs. These roosts may occur in rock outcrops and wildlife trees.

Size

Generally 12 ha but will depend on site-specific factors, including the proximity of alternate roosts. Further observations may determine whether this area is adequate.

Design

The WHA should include a 100 m radius core area and a 100 m radius management zone. When drafting boundaries consider bat movements between roosts during the breeding season, and the fact that bats may require several maternity trees per year for suitable roosting habitat. A similar design will be required for hibernacula, except the feature will be isolated and likely will not require connectivity.

General wildlife measures

Goals

1. Maintain all known roosting sites, including wildlife tree recruits for future roosting.
2. Maintain foraging habitat and prey abundance.
3. Minimize disturbance during critical times.
4. Minimize access.
5. Maintain riparian areas in a properly functioning condition.
6. Maintain hibernacula (if discovered).

Measures

Access

- Do not develop roads.
- Do not disturb rocky outcrops, loose boulders, or talus.

Harvesting and silviculture

- Retain some large trees (30–50 cm dbh) and all large (>50 cm dbh) ponderosa pine.
- Retain all large diameter (>30 cm dbh) wildlife trees (class 3–8).
- Prescribe logging in the lower diameter classes at a level that ensures future recruitment of large diameter stems and mimics a fire maintained stand (NTD4).
- Do not harvest or salvage between 1 May and 31 August if WHA includes a maternity colony.

Pesticides

- Do not use pesticides.

Range

- Plan grazing to meet GWM goals.

Recreation

- Do not establish recreation sites or trails, especially where trails would require the felling of wildlife trees.

Additional Management Considerations

Install bat-friendly gates to the entrance of caves and mines that have bat use. Install and maintain bat houses as part of the rehabilitation program. Bat Conservation International provides information regarding installation procedures of both gates and bat houses (www.batcon.org).

Information Needs

1. Specific roost requirements, especially tree roosts, in different biogeoclimatic zones, as well as effects of different silvicultural systems on roost and foraging habitat availability.
2. Seasonal roosting behaviours of maternity colonies, especially the strategies and spatial distribution of these roosts.
3. Hibernation sites need to be determined, as well as the distance travelled between hibernation sites and summer roosts.

Cross References

Bighorn Sheep, Spotted Bat, White-headed Woodpecker

References Cited

Black, H.L. 1974. A north temperate bat community: structure prey populations. J. Mamm. 43:138–157.

B.C. Conservation Data Centre (CDC). 2002. Rare vertebrate tracking lists. Available from: http:\srmwww.gov.bc.ca/cdc/tracking.htm

Collard, T.S. 1991. Identification of the status and critical habitats of the Fringed Bat (*Myotis thysanodes*), in the South Okanagan Valley, British Columbia. B.C. Min. Environ., Victoria, B.C. Unpubl.

Committee on the Status of Endangered Wildlife in Canada (COSEWIC). 2002. Canadian species at risk. Available from: http://www.speciesatrisk.gc.ca

Ewing, W.G., E.H. Studier, and M.J. O'Farrell. 1970. Autumn fat deposition and gross body composition in three species of *Myotis*. Comp. Biochem. Physiol. 36:119–129.

Firman, M. 1994. Thompson Region bat survey. B.C. Min. Environ., Kamloops, B.C. Unpubl.

Firman, M.C., C. Godwin, and R.M.R. Barclay. 1995. Bat fauna survey of the West Shuswap and South Thompson River region, British Columbia. Prepared for the B.C Min. Environ., Lands and Parks, Wildl. Br., Victoria, B.C. 94 p.

Holroyd, S.L., R.M.R. Barclay, L.M. Merk, and R.M. Brigham. 1994. A survey of the bat fauna of the dry interior of British Columbia: a summary by species with recommendations for future work. B.C. Min. Environ., Victoria, B.C. Wildl. Work. Rep. No. WR-63.

Martin, R.A. and B.G. Hawkes. 1972. Hibernating bats of the Black Hills of South Dakota. I. Distribution and habitat selection. Bull. New Jersey Acad. Sci. 17:24–30.

Maslin, T.P. 1938. Fringed-tailed Bat in British Columbia. J. Mammol. 19:373.

Milligan, B.N. 1993. A range extension for the Fringe-Tailed Bat, *Myotis thysanodes*, in British Columbia. Can. Field-Nat. 107:106–107.

Nagorsen, D.W. and R.M. Brigham. 1993. The bats of British Columbia. Univ. B.C. Press, Vancouver, B.C. 164 p.

Nagorsen, D.W., A.A. Bryant, D. Kerridge, G. Roberts, A. Roberts, and M.J. Sarell. 1993. Winter bat records for British Columbia. Northwest Nat. 74:61–66.

NatureServe Explorer. 2002. An online encyclopedia of life [Web application]. Version 1.6. Arlington, Va. Available from: http://www.natureserve.org/explorer

O'Farrell, M.J. and E.H. Studier. 1973. Reproduction, growth, and development in *Myotis thysanodes* and *M. lucifugus* (Chiroptera: Vespertilionidae). Ecology 54:18–30.

_____. 1976. Seasonal changes in wing loading, body composition, and organ weights in *Myotis thysanodes* and *M. lucifugus*. Bull. Soc. Calif. Acad. Sci. 75:258–266.

_____. 1980. *Myotis thysanodes*. Mammalian Species No. 137. 5 p.

Orr, R.T. 1956. The distribution of *Myotis thysanodes* in California. J. Mamm. 37:545–546.

Rabe, M.J., T.E. Morrell, H. Green, J.C. deVos, Jr., and C.R. Miller. 1998. Characteristics of ponderosa pine snag roosts used by reproductive bats in northern Arizona. J. Wildl. Manage. 62(2):612–621.

Rasheed, S.A., P.F.J. Garcia, and S.L. Holroyd. 1995. Status of the fringed myotis in British Columbia. B.C. Min. Environ., Lands and Parks, Wildl. Br., Victoria, B.C. Wildl. Work. Rep. No. WR-73.

Roberts, G. and A. Roberts. 1992. Grassland biodiversity in the Chilcotin Bunchgrass subzones and adjacent Douglas-fir subzone. B.C. Environ. and the B.C. Habitat Conserv. Fund, Victoria, B.C. 63 p. Unpubl.

Sarell, M.J. and A. Haney. 2000. South Okanagan rare bat survey 2000. Prepared for B.C. Environ., Penticton, B.C. 79 p.

Sarell, M.J., S. Robertson, and A. Haney. 1997. Inventory of Red- and Blue-listed wildlife within the Southern Boundary Forest District: Year One of Two. Prepared for Forest Renewal BC and B.C. Environ., Penticton, B.C.

Studier, E.H. and M.J. O'Farrell. 1972. Biology of *Myotis thysanodes* and *M. lucifugus* (Chiroptera: Vespertilionidae) – I. Thermoregulation. Comp. Biochem. Physiol. 41A:567–595.

Thomas, D.W. and S.D. West. 1991. Forest age associations of bats in the southern Washington Cascade and Oregon Coast Ranges. *In* Wildlife and vegetation of unmanaged Douglas-fir forests. L.F. Ruggiero, K.B. Aubry, A.B. Carey, and M.H. Huff (technical editors). U.S. Dep. Agric. For. Serv., Portland, Oreg., Gen. Tech. Rep. PNW-GTR-285, pp. 295–303.

Tuttle, M.D. and D. Stevenson. 1982. Growth and survival of bats. *In* Ecology of bats. T.H. Kunz (technical editor). Plenum Press, New York, N.Y., pp. 105–150.

van Zyll de Jong, C.G. 1985. Handbook of Canadian mammals. 2. Bats. Natl. Mus. Nat. Sci. (Canada), Ottawa, Ont. 212 p.

Whitaker, J.O., Jr., C. Maser, and L.E. Keller. 1977. Food habits of bats of western Oregon. Northwest Sci. 51(1):46–55.

Williams, D.F. 1968. A new record of *Myotis thysanodes* from Washington. Murrelet 49:26–27.

GRIZZLY BEAR

Ursus arctos

Original prepared by Les Gyug, Tony Hamilton, and Matt Austin

Species Information

Taxonomy

The Grizzly Bear, *Ursus arctos*, is one of eight species of the bear family, Ursidae. There are currently two recognized North American subspecies*: U. arctos horribilis*, the common subspecies, and *U. arctos middendorffi*, the Kodiak bear, found on a few Alaskan coastal islands.

Description

Bears are different from other carnivores by their greatly enlarged molar teeth with surfaces that have lost their shearing function and are adapted to crushing, in keeping with their omnivorous diets. The forelimbs are strongly built and the feet are plantigrade and have five toes. Forefeet have long, non-retractile claws. The ears are small and the tail is extremely short.

The Grizzly Bear is the second largest member of the bear family next only to the polar bear (*U. maritimus*). Grizzlies are large, heavy-bodied bears that can attain weights of up to 500 kg (average range 270–360 kg). Exceptionally large bears have been recorded at 680 kg. Adult grizzlies reach nose-to-tail lengths of 1.8 m on average but have been recorded as long as 2.7 m. The long, outer guard hairs of the Grizzly Bear are often tipped with white, silver, or cream giving the bear a grizzled appearance. Coat colour is quite variable, usually brown but ranging from black to almost white. Coat colour is not a good characteristic for distinguishing between Grizzly Bears and Black Bears (*Ursus americanus*). Grizzly Bear facial profiles are usually "dished-in" and a hump of muscle is normally present on the shoulders. The front claws on a Grizzly Bear are longer than on Black Bears, being as long as 10 cm. The long front claws and hump of muscle on the shoulders are adaptations for digging.

Distribution

Global

The Grizzly Bear has a circumpolar distribution once covering most of North America, Europe, and the northern part of Asia. In many of these areas it has been exterminated or its numbers have been greatly reduced. Most of the world's Grizzly Bears now occur in northwestern North America and Russia.

In North America, Grizzly Bears once ranged over most of the west, from Alaska south to Mexico, and from the Pacific coast east to Manitoba, and the Missouri River (Banci 1991). In the wake of westward development and settlement, especially in the plains, the range of the grizzly shrank to its present distribution of Alaska, the Yukon Territory, and British Columbia, with small populations in Alberta, the Northwest Territories, Montana, Idaho, and Wyoming.

British Columbia

Grizzly Bears historically occurred throughout British Columbia, with the exception of some coastal islands (e.g., Vancouver Island, Queen Charlotte Islands, and others). Populations are considered extirpated from much of south and southcentral British Columbia (e.g., lower elevations of the Okanagan, the Lower Mainland, and parts of the Cariboo). However, Grizzly Bear are occasionally sighted in the southern interior plateaus and other areas from which their populations are considered effectively extirpated.

Forest regions and districts

Grizzly Bears occur in all forest regions and almost all forest districts **except** South Island, and Queen Charlotte Islands, and only in the mainland portions of the Campbell River and North Island forest districts.

Ecoprovinces and ecosections

Grizzly Bears occur in most ecoprovinces and ecosections in mainland British Columbia but are absent from Vancouver Island and Queen Charlotte Islands. The following are mainland ecosections within which Grizzly Bear populations are considered **extirpated:**

BOP: PEL, and parts of CLH, HAP, KIP
CEI: CAB, FRB, and parts of CAP, CHP, NAU, QUL
COM: NWC, and parts of EPR, SPR
GED: GEL, FRL
SOI: SOB, SOH, NOB, THB and parts of NOH, NTU, OKR, PAR, STU

Biogeoclimatic units

Grizzly Bears occur in all biogeoclimatic units except BG and CDF.

Broad ecosystem units

Grizzly Bears are wide ranging, and can occur in most broad ecosystem units.

Elevation

All elevations from sea level estuaries to high alpine meadows and talus slopes.

Life History

Diet and foraging behaviour

In British Columbia, Grizzly Bears are efficient predators and scavengers but rely more on a vegetative diet. Grizzly Bears consume a wide variety of foods, including roots and green vegetation, small and large mammals, fish, and insects. A huge variety of plant, animal, fish, and insect food sources are regionally important. Grizzly Bears are omnivorous and opportunistic in their feeding habitats. Habitat selection is governed by forage availability during the growing season. Grizzly Bear diet also changes with the seasons to make use of the most digestible foods. For example, Grizzly Bears will take advantage of palatable early spring forage. Feeding on ungulates is important during early spring, and for many bears, salmon comprises a significant fall diet item.

In general, the largest differences in the feeding patterns are between coastal and interior Grizzly Bears. On the coast (MacHutchon et al. 1993; Hamilton 1987), beginning in the spring, Grizzly Bears feed on early green vegetation such as skunk cabbage (*Lysichiton americanus*) and sedges located in the estuaries and seepage sites that become snow-free first. As the season advances, the bears follow the receding snow up the avalanche chutes feeding on emerging vegetation and roots. Ripe berries attract the grizzlies down onto the floodplain and lower slopes where they eat devil's-club (*Oplopanax horridus*), salmonberry (*Rubus spectabilis*), raspberry (*Rubus* spp.), black twinberry (*Lonicera involucrata*), elderberry (*Sambucus* spp.), and a variety of blueberries (*Vaccinium* spp.). They begin to feed on salmon (*Oncorhynchus* spp.) as they become available in the spawning channels and continue to do so until late fall, feeding on live and eventually dead salmon. Once salmon supplies dwindle, grizzlies return to feeding on skunk cabbage and other vegetation. Grizzlies will feed on insects and grubs when the opportunity arises, as well as molluscs and other animals of the intertidal zone.

In the interior (Simpson 1987; McLellan and Hovey 1995; Ciarniello et al. 2001) beginning in the spring, grizzlies feed mainly on the roots of *Hedysarum* spp., spring beauty (*Claytonia lacneolata*), and/or avalanche lily (*Erythronium grandiflorum*) depending on local abundance, and on carrion. They may also opportunistically prey on winter-weakened ungulates. As the green vegetation emerges the bears begin to graze on grasses, horsetails, rushes, and sedges. During this time, they also prey on ungulates on their calving grounds. In summer, bears follow the green-up to obtain nutritious young spring growth including locally important food sources such as cow-parsnip (*Heracleum* spp.). They also obtain early ripening fruits beginning in mid-July mainly in riparian forests and productive low elevation seral forests, such as pine-soopolallie terraces. In late-summer and fall (August–October) high elevation berries become the major food source, mainly soopolallie (*Shepherdia canadensis*), blueberries, and huckleberries. Late fall feeding focuses mainly on harder berries such as mountain ash (*Sorbus* spp.) or kinnickinnick (*Arctostaphylos uva-ursi*) that persist past the *Vaccinium* fruiting season, and on the roots of *Hedysarum* in areas where it occurs. Throughout the active season, interior grizzlies will prey on small mammals, especially ground squirrels (*Spermophilus* spp.) Fish, roots, pine nuts, or bulbs, and insects are important whenever they are available and sufficiently abundant. Army cutworm moths (Noctuidae) in high elevation alpine talus slopes and boulder fields may be locally important (White et al. 1998a).

Reproduction

Breeding occurs between the end of April and end of June. Cubs are born in the den between January and March. The average age of first reproduction for females in southeastern British Columbia is 6 years, the time period between litters is 2.7 years, and the mean number of cubs per litter is 2.3 (McLellan 1989a). In southern grizzly populations, cubs tend to stay with the mother for approximately 2.5 years. Females remain in estrus throughout the breeding season until mating occurs and do not ovulate again for at least 2 (usually 3 or 4) years after giving birth. Two offspring are generally born per litter, and young are born blind and without fur. They are weaned at 5 months of age but remain with the mother until at least their second spring (and usually until the third or fourth).

Site fidelity

Many telemetry studies have shown that Grizzly Bears are creatures of habit and will usually return to the same seasonal food sources and areas throughout their lifetimes. Foraging strategies are somewhat flexible; individuals adapt to annual variation in food supply and can learn to exploit newly available food sources. However, many of a Grizzly Bear's movements, habitat selection, and foraging patterns are learned as a cub and are reinforced throughout their lives (20–30 yr). Home range fidelity may be strong as a result, especially for females.

Home range

Home range sizes are proportionate to food quality, quantity, and distribution. Generally Grizzly Bear home ranges in productive coastal habitats near salmon stream are smaller than ranges in interior mountains, which are again smaller than ranges in interior plateau habitats. For coastal British Columbia, average minimum single year home range size was 137 km^2 for males, and 52 km^2 for females (Khutzeymateen: MacHutchon et al. 1993). For wet interior mountains, average home range size was 187 km^2 for males and 103 km^2 for females (Parsnip: Ciarniello et al. 2001; Revelstoke: Simpson 1987). For drier interior mountains or plateau areas, average home range size was 804 km^2 for males and 222 km^2 for females (Parsnip: Ciarniello et al. 2001; Flathead: McLellan 1981; Jasper: Russell et al. 1979; Kananaskis: Wielgus 1986).

Grizzly Bears, except females with cubs, and sibling groups, are solitary for most of the year except during the mating season. Mothers, daughters, and even granddaughters tend to have overlapping home ranges, while male home ranges are large and overlap with several adult females (Bunnell and McCann 1993). Habitat use and food habits studies have shown that the areas occupied by male grizzlies (200-300 km^2) are much larger than what would be required simply to obtain food. The smaller range sizes of females with young (100 km^2), which have greater energy needs than males, may provide the best estimate of the minimum feeding habitat requirements of individual bears. The large range sizes of male Grizzly Bears are probably related more to breeding than to food availability, while females may use small ranges where they can improve security of the young while still obtaining adequate food. Social intolerance and security needs of young bears probably act to distribute grizzlies widely over the available range. In many areas, adult females may inhabit marginal ranges or disturbed areas, such as road margins, where human activities exclude most larger males (McLellan and Shackleton 1988). The size of individual home ranges varies annually in response to variation in quality and abundance of food (Picton et al. 1985). Grizzly Bear habitat use is strongly influenced by intraspecific social interactions (e.g., male predation on cubs) and the presence and activities of people.

Movements and dispersal

Grizzly Bears have low dispersal capabilities relative to other carnivores (Weaver et al. 1996). This is especially true for subadult female Grizzly Bears, which usually establish their home range within or adjacent to the maternal range (e.g., McLellan and Hovey 2001). On average, male Grizzly Bears only dispersed 30 km from the ranges used as cubs with their mothers, and female Grizzly Bears only 10 km (McLellan and Hovey 2001). This inherent fidelity, particularly of female Grizzly Bears, to their maternal home ranges may reduce the rate of recolonization of areas where breeding populations have been depleted.

Habitat

Structural stage

In general terms, Grizzly Bear forage tends to be more abundant in non-forested sites, or sites with partial forest, or sites with many tree gaps in older forest. However, security habitat and day bedding areas (for heat relief, rain interception, or warmth) tend to be closed forest sites near higher quality foraging sites. Some types of forage (e.g., salmon in streams, ants in logs, ungulates) can be found within many structural stages and the forage is not necessarily tied to any particular structural stage. (Refer to Table 1 on following page.)

Important habitats and habitat elements

Denning

Denning sites are generally used from November through March and usually to mid-April in the northern areas of British Columbia. Hibernating habitats tend be high elevation areas that are sloped, and have dry, stable soil conditions that remain frozen during the winter (Bunnell and McCann 1993). Dens are usually on steep north-facing slopes, with soils suitable for digging and where vegetation will stabilize the roof of the den and snow will accumulate for insulation (Vroom et al. 1977). Wet or seepage areas and areas with shallow soils or many boulders are avoided. Bears seldom reuse an excavated den but will often come back to the same vicinity to dig their new den (Ciarniello et al. 2001).

On the coast, dens are often dug under large old trees. The tree's root mass creates a stable roof for the den. Coastal grizzlies may also use very large tree cavities much like coastal Black Bears.

Foraging

Grizzly Bears in British Columbia have such an enormous range of learned behavioural adaptations to diverse regional ecosystems that generalization about habitat requirements is difficult. Even within a region, individual bears may have vastly different approaches to meeting their requirements. Some bears, particularly males, adopt a highly mobile, seasonally "transient" strategy, whereas other bears are more "resident." Some bears rely more heavily on predation than others, and some use higher elevation annual home ranges as opposed to migrating to lower elevations on a seasonal basis.

Although meeting nutritional requirements is the primary factor in habitat choice, selection is also based on thermal cover (e.g., dens/bedding sites), security (e.g., females protecting cubs), or access to potential mates during the breeding season. Habitat selection is also strongly influenced by intra-specific (social) interactions and the presence and activities of people.

Grizzly Bear habitat requirements must be viewed at several spatial scales. Transients deliberately travel to specific landscapes in a sub-region on a seasonal basis. Both residents and transients select specific patches of habitat or complexes of habitats within landscapes. Within patches, they may only require specific food-producing microsites. Habitat requirements must also be viewed at various temporal scales; continually shifting seasonal food supplies, annual food variance (e.g., berry crop failure), and

Table 1. Forage values by structural stage

Stage	Value
1a	Forage value for army cutworm moths in alpine rockfields or intertidal marine molluscs in estuaries. Otherwise generally nil forage value except in the presence of human foods or garbage. Seasonal use of small mammals (marmots and ground squirrels).
1b	Forage value for army cutworm moths in alpine rockfields. Forage value for intertidal marine molluscs in estuaries. Otherwise generally nil forage value except in the presence of human foods or garbage.
2	Forage value can be very high on bulbs, corms, grasses, horsetails, and other herbs. These values can be found variously in wet meadows, marshes, avalanche slopes, or alpine/subalpine meadows.
3a	Forage value can be very high, particularly in recovering burned or clearcut sites where *Vaccinium* berries are abundant.
3b	Forage value can be very high, particularly in recovering burned or clearcut sites where *Vaccinium* berries are abundant. Forage value can be high in skunk cabbage swamps, which are usually a mixture of structural stages because the typical skunk cabbage swamp is often partially treed, and contains tall alder or willow shrubs as well. Similarly typical avalanche slopes are mixtures of herb, low shrub, and tall shrub stages, all of which can provide high forage values for Grizzly Bears.
4	Typical value of densely forested sites, which preclude most herb or shrub forage values, are as day bedding sites for security and heat relief in areas near other types of foraging sites. Forests that are not as densely forested may continue to support berry patches (soopolallie or *Vaccinium*) in forests beyond the open shrub stage.
5	Typical value of densely forested sites, which preclude most herb or shrub forage values, are as day bedding sites for security and heat relief in areas near other types of foraging sites. Forests that are not as densely forested may continue to support berry patches (soopolallie or *Vaccinium*) in forests beyond the open shrub stage.
6	Typical value of densely forested sites, which preclude most herb or shrub forage values, are as day bedding sites for security and heat relief in areas near other types of foraging sites. Forests that are not as densely forested may continue to support berry patches (soopolallie or *Vaccinium*) in forests beyond the open shrub stage.
7	Value of forest (beyond security and heat relief) will depend on amount of openings in forest. Forests that remain dense in stage 7 will have little value beyond that found in stages 4, 5, and 6. Forests that become patchy with numerous gaps or dying canopies may support various amounts of berries or herbs for foraging in the canopy gaps.

long-term influences on habitat quality such as fire suppression must all be considered. Concurrent attention must be given to meeting the spatial requirements of individuals within and across landscapes and examining population level habitat supply.

Conservation and Management

Status

Grizzly Bears are on the provincial *Blue List* in British Columbia. In Canada, Grizzly Bears are considered of *Special Concern* in British Columbia and *Extirpated* in part of Alberta, Saskatchewan, and Manitoba (COSEWIC 2002). (See Summary of ABI status in BC and adjacent jurisdictions at bottom of page.)

Trends

Population trends

The provincial population estimate from the B.C. Ministry of Water, Land and Air Protection for Grizzly Bears is estimated at a minimum of 13 800, which is ~50% of the Canadian Grizzly Bear population. Overall, the population in British Columbia currently appears stable, but local population declines have occurred in the past in many areas of the province. Grizzly Bears are considered threatened in 8% of their historic range in British Columbia and effectively extirpated in ~10% (Figure 1). Grizzly bear populations are believed to be increasing in some areas of the province.

Habitat trends

Habitat effectiveness for Grizzly Bears has decreased in British Columbia and can be expected to continue to decrease in British Columbia (MELP 1995b). Habitat effectiveness considers the habitat suitability of the area and further accounts for impacts such as habitat displacement and fragmentation that reduce the ability or willingness of Grizzly Bears to use the habitat. While some of this is due to direct loss to agriculture and settlement, increasing road access is now more important. Road access leads to direct mortality through increased human–bear conflicts, hunting, and poaching, and an avoidance of habitats near roads and areas heavily used by people for recreation, resource extraction, or other reasons.

Threats

Population threats

Historic reductions in Grizzly Bear populations were a result of extensive agricultural land conversion, extermination campaigns often related to livestock protection, and unrestricted killing (IGBC 1987). Today, the primary limiting factors for Grizzly Bears in the Canadian portion of their range appear to be human-caused mortality from a variety of factors, and habitat loss, alienation, and fragmentation (McLellan et al. 2000; Kansas 2002).

Currently, throughout the Grizzly Bear's range in North America, sources of area-concentrated mortality include hunting, poaching, and control kills associated with inadequate garbage management or other types of human-bear encounters including protection of livestock or perceived threats to human safety (IGBC 1987). In southern British Columbia,

Summary of ABI status in BC and adjacent jurisdictions (NatureServe Explorer 2002)

AB	AK	BC	ID	MT	YK	NWT	WA	Canada	Global
S3	S?	S3	S1	S1S2	S?	S?	S1	N3	G4T3T4

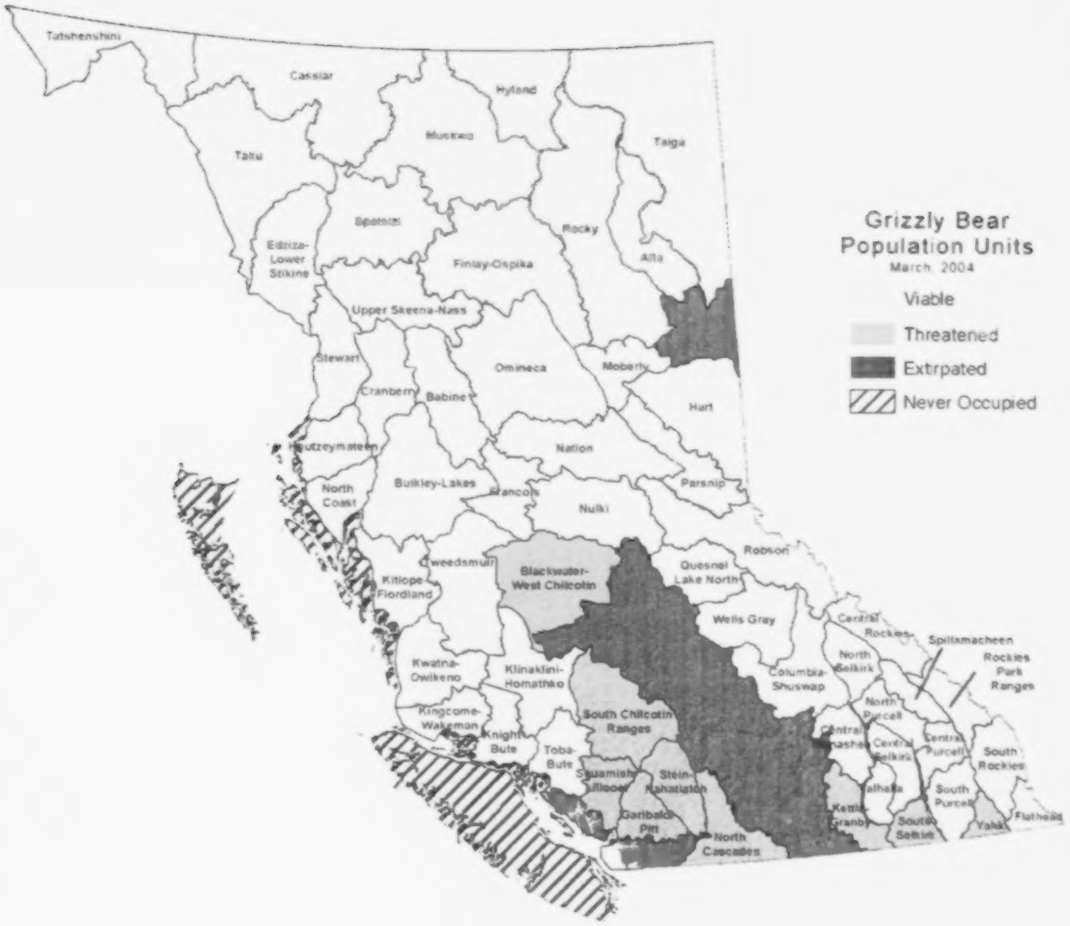

Grizzly Bear Population Units
March 2004
Viable
Threatened
Extrpated
Never Occupied
Tatshenshini
Cassiar
Hyland
Muskwa
Taiga
Taku
Spatsizi
Rocky
Edziza-Lower Stikine
Finlay-Ospika
Alta
Upper Skeena-Nass
Stewart
Omineca
Moberly
Cranberry
Babine
Hart
Khutzeymateen
Nation
North Coast
Bulkley-Lakes
Francois
Nulki
Parsnip
Robson
Tweedsmuir
Blackwater-West Chilcotin
Quesnel Lake North
Kitlope-Fiordland
Wells Gray
Central Rockies
Spillamacheen
Kwatna-Owikeno
Klinaklini-Homathko
North Selkirk
Columbia-Shuswap
Rockies Park Ranges
North Purcell
Kingcome-Wakeman
South Chilcotin Ranges
Knight-Bute
Toba-Bute
Central Monashee
Central Selkirk
Central Purcell
South Rockies
Squamish-Lillooet
Stein-Nahatlatch
Valhalla
South Purcell
Kettle-Granby
Garibaldi-Pitt
South Selkirk
Yahk
Flathead
North Cascades

Figure 1. Status of Grizzly Bear Population Units (MWLAP). Population conservation status is based on the percentage the current population estimate represents of the capability of the habitat to support Grizzly Bears. The conservation status categories are: Viable ≥50%; Threatened <50%.

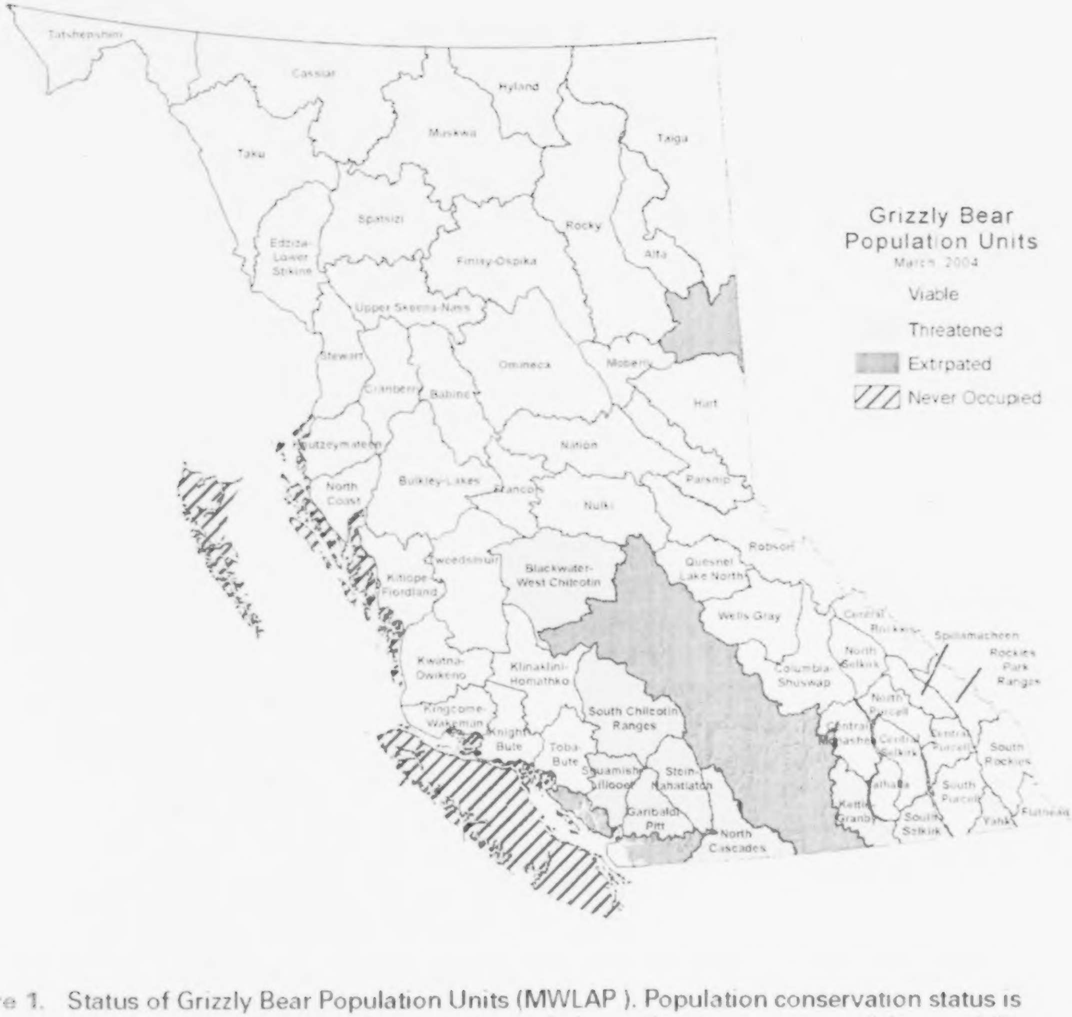

Tatshenshini
Cassiar
Hyland
Taku
Muskwa
Taiga
Spatsizi
Rocky
Edziza-Lower Stikine
Finlay-Ospika
Alta
Upper Skeena-Nass
Stewart
Omineca
Moberly
Cranberry
Babine
Hart
Khutzeymateen
Nation
North Coast
Bulkley-Lakes
Francois
Parsnip
Nulki
Robson
Tweedsmuir
Blackwater-West Chilcotin
Quesnel Lake North
Kitlope-Fiordland
Wells Gray
Central Rockies
Spillamacheen
Rockies Park Ranges
North Selkirk
Kwatna-Owikeno
Klinaklini-Homathko
Columbia-Shuswap
North Purcell
Kingcome-Wakeman
South Chilcotin Ranges
Central Monashee
Central Selkirk
Central Purcell
South Rockies
Knight-Bute
Toba-Bute
Squamish-Lillooet
Stein-Nahatlatch
Valhalla
South Purcell
Kettle-Granby
South Selkirk
Yahk
Flathead
Garibaldi-Pitt
North Cascades
Grizzly Bear Population Units
March 2004
Viable
Threatened
Extirpated
Never Occupied

Figure 1. Status of Grizzly Bear Population Units (MWLAP). Population conservation status is based on the percentage the current population estimate represents of the capability of the habitat to support Grizzly Bears. The conservation status categories are: Viable ≥50%; Threatened <50%.

and adjacent areas of the interior mountains, people killed 77–85% of 99 radio-collared bears known or suspected to have died during 13 radio-collaring studies in a 22-year period (McLellan et al. 2000). In British Columbia where Grizzly Bear hunting was permitted, legal harvest accounted for 39–44% of the mortality. The next leading cause of grizzly mortality was killing by people in self-defence or in defence of property or livestock. Similar extensive data to estimate mortality rates is not available for northern British Columbia where fewer radio-collaring studies have been undertaken.

Increased direct Grizzly Bear mortalities are often associated with increased road access (McLellan 1990). Roads result in Grizzly Bear mortalities both directly and indirectly (as well as habitat loss; see "Habitat threats"). The mechanisms in which mortality is increased include direct mortality both through collisions on major roads, and through hunting and poaching; habituation of bears to people when they come in close contact, and the eventual loss of some of these bears involved in human-bear conflicts; and social disruption of bears with other bears when bears start avoiding habitat near newly created roads (McLellan 1990). Most of the new road building in British Columbia stems from forestry, mining, and oil and gas development. Direct human-caused mortality represents a particularly significant threat when adult females are killed in small and localized populations that may have low immigration rates.

Isolation is a significant factor in long-term (100+ yr) viability of small isolated Grizzly Bear populations such as in the Yellowstone area in the northwestern United States (Mattson and Reid 1991). The low population numbers in some areas of British Columbia are so low as to make natural recovery almost impossible given that these areas can be fairly isolated from the other Grizzly Bear population and natural immigration is likely very low. The low population numbers and isolation of localized populations such as in the North Cascades (e.g., estimate of <20; Gyug 1998) may also be creating local inbreeding that may limit any population recovery in these areas in the absence of increased Grizzly Bear immigration.

By comparison to human-caused mortality, natural mortality factors seem to be relatively minor in Grizzly Bear populations (McLellan et al. 2000). There are no known diseases or parasites that appear to have impacts on natural populations of Grizzly Bears (IGBC 1987). Predation/cannibalism, particularly of young bears by older dominant male bears, appears to play a role in population regulation, but its extent is not well known. Malnutrition is a factor in cub mortality, often within the first 1–4 weeks of emergence from the den, indicating that the nutritional state of the pregnant female entering the den is important (IGBC 1987).

Habitat threats

Habitat loss, alienation (the displacement from otherwise suitable habitat), and fragmentation (the separation of previously continuous habitat into one or more disconnected pieces) occur on a broad scale as a result of expanding human settlement, increased access for forestry and other extraction industries, and forestry and fire suppression.

Human settlement

Urban and agricultural developments are concentrated in valley bottoms formerly used as spring habitats and as movement corridors between mountain ranges. These developments cause direct habitat loss as well as habitat fragmentation by isolating major protected areas, sometimes making them inadequate to maintain viable populations. The settlement patterns along major roads or highways also tend to cause habitat fragmentation. The increasing settlement patterns along the Highway 3 corridor through the Rocky Mountains in southern British Columbia is seen as one of the major population fragmentation causes preventing extensive Grizzly Bear population recovery in the northern Rocky Mountains of the United States.

Because Grizzly Bear populations are naturally found at low densities, large areas of occupied and connected habitat are required to ensure their long term viability. To sustain habitat supply for populations, individuals must be able to move freely among valued habitats, without being restricted by human-caused blockages or being attracted to mortality sinks around human settlements. Because individuals tend to disperse very little from established populations (10–30 km; McLellan and Hovey 2001), it is necessary to maintain corridors of habitat between major protected areas that are also good habitat themselves and corridors must be "wide enough for male Grizzly Bears to live in with little risk of being killed" (McLellan and Hovey 2001).

Hydroelectric impoundments behind dams can significantly affect Grizzly Bears when lowland feeding areas, particularly important in spring, are flooded. The effect of dams, particularly on the Columbia River system, has been to stop anadromous salmon runs, which has probably significantly affected Grizzly Bear feeding opportunities over a very wide area as well.

Forest management

Before the advent of widespread fire suppression (about 1945), the primary forest disturbance regime was fire through most of the province. Currently, logging has replaced fire as the primary agent of forest succession, which can be expected to have an impact on Grizzly Bear habitat independent of any effects of increased access (Zager et al. 1983). Many post-fire habitats typically remain high productivity foraging sites (particularly for berries) for 35–70 years, and Grizzly Bears learn to rely heavily on these sites. Under current timber management and silvicultural regimes, extensive site preparation and soil disturbance by heavy machinery reduce berry productivity in clearcuts, and conifer stands are planted, managed, and tended so they close in and lose any berry foraging values within much shorter time frames than they might have had under natural wildfire regimes.

Grizzly Bears typically used forested habitats adjacent to open foraging habitats such as avalanche chutes, wet meadows, marshes and swamps, and subalpine meadows as security habitat and daytime bedding sites to avoid heat stress. Clearcutting the forests adjacent to these sites can significantly affect the suitability in these high value open sites.

Roads

Roads result in Grizzly Bear habitat alienation, (i.e., displacement from preferred habitats), as well as increased direct mortality from hunters, poachers, and management kills for bears that are not displaced (McLellan 1990; Mace et al. 1999). Vehicles on roads may harass bears, and roads tend to displace them from quality habitats (McLellan 1990). Roads also tend to result in increased human activity in areas, which increases chances for bear–human interactions that result in displacement from these habitats (as well as increases in direct mortality) (McLellan 1990).

The displacement of bears from linear habitats (i.e., roads) can also cause habitat fragmentation. In Banff National Park, the Trans-Canada Highway acts as a complete barrier to adult females, and secondary highways are only regularly crossed by female Grizzly Bears that are relatively habituated to people (Gibeau and Herrero 1998). In British Columbia, the Highway 3 corridor near Nelson/Castlegar/Trail/Salmo has been found to be a genetic barrier between southern Selkirk and central Selkirk mountain Grizzly Bear populations (Proctor 2001). Where there are still extant populations of Grizzly Bears in the northern United States, highways also cause habitat fragmentation (Servheen et al. 1998).

While the construction of access roads is not limited to forestry activities, most new roads constructed in British Columbia are to support forestry activities. The increased access allowed on even infrequently travelled roads has been shown to significantly affect habitat use by Grizzly Bears (e.g., Mace et al. 1996; Archibald et al. 1987; McLellan and Shackleton 1988). Even increases in non-motorized and non-hunting-related recreation allowed by increased access to areas can significantly affect Grizzly Bear habitat use (e.g., for mountain climbing) (White et al. 1998b). While road closures or access limitations can be implemented to reduce the effects of forest access roads on Grizzly Bears, road closures implemented in wildlife management areas on national forests in Idaho, Wyoming, Washington, and Montana were found to be relatively ineffective

(27%) at keeping all vehicles off closed roads (Havlick 1998).

Historically, conflict with ranchers and livestock grazing operations have been a major cause of Grizzly Bear population decline or local extirpation in the United States (Storer and Trevis 1978), and this impact is thought to have reduced British Columbia populations as well. Potential impacts include mortalities if ranchers shoot bears to protect livestock, competition for forage, displacement from or alteration of preferred habitats from grazing and trampling. Preferred habitats which may be impacted by grazing or trampling include wetland areas and fruit-producing areas (IGBC 1987). More information on grazing impacts on grizzly bears is provided in the IGBC (1987).

Legal Protection and Habitat Conservation

The Grizzly Bear is protected under the provincial *Wildlife Act* from unrestricted hunting. All hunting seasons on Grizzly Bears are managed through Limited Entry Hunts (LEH) open by lottery to resident hunters or by quotas granted to licensed guides. There are no LEH seasons on Grizzly Bears in any threatened Grizzly Bear Population Unit.

Within the occupied range of Grizzly Bears in British Columbia, >106 000 km^2 or 13.4% is protected. Some parks that are important for the conservation of Grizzly Bears include Khutzeymateen, Spatsizi, North and South Tweedsmuir provincial parks and Tatshenshini-Alsek National Park.

The Grizzly Bear Conservation Strategy (MELP 1995a) identified habitat as one of the key conservation needs for Grizzly Bears in British Columbia and established a framework for establishing Grizzly Bear management areas throughout the province. Habitat management would largely be achieved through strategic land use plans that would establish goals and objectives, and would set the means to attain those on publicly owned land in local areas throughout the province.

Strategic land use planning on publicly owned lands, either land use plans (LUP) or land and resource management plans (LRMP), have been completed or approved in 73% of the province by area as of January 2002. LRMP processes are underway in an additional 12% of the area or the province.

Most of the strategic land use plans that have been completed or approved to date address Grizzly Bear habitat issues (Table 2), some in more detail and length than others. In particular, LRMPs such as the Okanagan-Shuswap and Kalum have addressed Grizzly Bear habitat issues at great length and in detail, while others, such as the Kootenay-Boundary LUP, appear to have treated Grizzly Bear habitat issues only in part, and the Kamloops LRMP is silent on the issue of Grizzly Bear habitat management.

Identified Wildlife Provisions

Sustainable resource management and planning recommendations

Given that Grizzly Bears have large home ranges, both the landscape and stand level requirements of Grizzly Bears should be considered during strategic or landscape level planning. Wildlife habitat areas may be established under strategic level plans to address stand level requirements, provided a timber supply budget is negotiated by the strategic level plan or under the IWMS provincial timber supply limit (see "Wildlife habitat area" below) when within a Threatened Grizzly Bear Population Unit or Grizzly Bear Management Area.

The following strategic level recommendations may be considered for translation into specific legal objectives, strategies, and general guidelines by the strategic level plan and must be clearly defined geographically at an appropriate map scale. The intent is to apply these recommendations to ensure that:

- adequate amounts of well-distributed, seasonally important habitats are available across the landscape and through time;
- these habitats can be effectively used by Grizzly Bears (i.e., areas are not unduly impacted by habitat fragmentation or displacement resulting from human activities); and
- human-caused mortality risks are minimized.

Table 2. Current approaches to Grizzly Bear habitat management within strategic land use plans in British Columbia. LRMPs are underway in the North Coast, Central Coast, Lillooet, and Sea to Sky. No LRMPs or LUPs are underway in Atlin-Taku, Dease Liard, Nass, Morice, Sunshine Coast, Merritt, or Chilliwack.

Strategic land use plan	**Type of resource management zone (RMZ)**	**Approach to Grizzly Bear habitat management** ***General or specific objectives or area-based direction for Grizzly Bear habitat management***
Fort Nelson	37 area-specific RMZs	Objectives included recommendations to manage and minimize new access, to ensure industrial exploration and timber management activities are undertaken with sensitivity to Grizzly Bear habitat, and to identify and map important habitat elements incorporated into several RMZs.
Cassiar Iskut- Stikine	15 area-specific RMZs	Objectives include maintenance of large areas of high value Grizzly Bear habitat (which have been mapped) by maintaining areas of well-distributed, seasonally important habitats for Grizzly Bear across the landscape and through time. Strategies are spelled out and include managing all access to and activities in these areas, and maintaining mixes of seral stages for forage and other critical habitat features including connectivity of habitats. In addition, access management is to take into account high value Grizzly Bear habitats.
Mackenzie	72 area-apecific RMZs and RM subzones	Under general directions the objectives are to identify and manage to conserve Grizzly Bear habitat to assist in sustaining viable populations; improve the management of interactions between Grizzly Bears and humans; and manage access to maintain healthy Grizzly Bear populations. Strategies to achieve these objectives are included (i.e., developing guidelines for silviculture, timing and activities in high or spring Grizzly habitats, establishment of WHAs).
Fort St. John	24 area-specific RMZs	Objectives and strategies are given for each RMZ, and include Grizzly Bear habitat management in some RMZs where Grizzly Bear management was a priority. For example, in one RMZ, an objective to "Maintain medium and high quality Grizzly Bear habitat" has strategies specified to identify and map the habitat; incorporate habitat protection criteria into landscape and stand level plans; plan and develop access to avoid habitats; incorporate habitats and connectivity corridors into landscape level plans; use WHAs, develop interagency plans where there is the potential for activities to negatively affect habitat; encourage the use of silvicultural systems that minimize negative impacts on habitat; and minimize impacts by ensuring that critical habitat areas are linked by connectivity corridors.
Dawson Creek	12 area-specific RMZs	Specific directions have been left to lower level planning initiatives. Several RMZs contain the following objective: "Manage medium and/or high capability Grizzly Bear habitat to assist in sustaining viable, healthy Grizzly Bear populations" using the strategy of identifying and mapping medium and high capability Grizzly Bear habitat, and incorporating into landscape unit level and operational planning."

Strategic land use plan	Type of resource management zone (RMZ)	Approach to Grizzly Bear habitat management *General or specific objectives or area-based direction for Grizzly Bear habitat management*
Fort St. James	36 area-specific RMZs	Two objectives in general directions are to maintain or enhance Grizzly Bear habitat and populations, and to minimize conflicts in human–bear interactions. The strategies to achieve the first objective include completing Grizzly Bear habitat mapping in areas of concern; managing for a mosaic of habitat types and characteristics to ensure adequate seasonal foraging sites with adjacent cover; reducing habitat fragmentation by providing FENs or movement corridors; and in high Grizzly Bear habitat suitability areas, undertaking access management planning, establishing management zones around important and valuable habitats, timing development to minimize conflicts, minimizing Grizzly Bear displacement from preferred habitats, creating irregular edges and leaving cover within cutblocks and between cutblocks and roads, and locating roads to avoid valuable Grizzly Bear habitat.
Kispiox	18 area-specific RMZs (not including Protected Areas)	Extensive Grizzly Bear habitat management strategies are included in the general management directions, rather than in area-specific RMZs. Listed strategies include identifying and mapping high value habitat at the landscape planning level that will be protected through management strategies such as buffering with reserves, modifying silvicultural systems, and minimizing clearcut sizes; selection harvesting a minimum of 5% of the forested portion of high value Grizzly Bear habitat outside RMAs or WHAs; using established strategies for management of Grizzly Bear habitat in the development and review of landscape and operational plans, designation of Grizzly Bear management areas, co-ordinated access management plans and modified road construction; and restricting Grizzly Bear hunting in portions of the planning area as part of the provincial conservation strategy.
Kalum	Generic land use class RMZs	Grizzly Bear habitat importance, and objectives and strategies for management are extensively laid out at more length and with more specifics than in any other LRMP. Intent of these objectives and strategies was to maintain or restore Grizzly Bear habitats through access management and forage supply for identified watersheds; conserve, mitigate, or restore critical patch habitats at the stand level no matter where they occur; maintain current Grizzly Bear population density, distribution, and genetic diversity in each GBPU to ensure viability; and recover local Grizzly Bear population where appropriate. The Special RMZ class was divided into 9 types, one of which is "Grizzly Bear benchmark and linkages." Three Special Grizzly Bear RMZs were created as benchmark or linkage habitats where no hunting is allowed, in addition to the general management directions.
Bulkley	Generic land use RMZs, with	12 Planning Units overlaid on RMZs Specific directions for Grizzly Bear management are given in each of 12 Planning Units (or for subunits). Directions are relatively generic, e.g., "Maintain goat and Grizzly Bear habitat. Prescriptions will focus on the importance of maintaining Grizzly Bear habitat, especially that required for travel and denning," or "Complete Grizzly Bear interpreted ecosystem mapping and incorporate into management prescriptions as directed by the Babine Local Resource Use Plan (LRUP). Actual management of habitats defaults to lower level plans (LRUP or IWMS).

Strategic land use plan	Type of resource management zone (RMZ)	Approach to Grizzly Bear habitat management *General or specific objectives or area-based direction for Grizzly Bear habitat management*
Lakes	Established generic land use RMZs	General management direction objectives are to "maintain the diversity and a suitable abundance of wide ranging carnivore populations and the ecosystems upon which they depend." Strategies to implement this for Grizzly Bears include upgrading capability/suitability mapping, establishing Grizzly Bear management plans and management areas in accordance with the provincial Grizzly Bear conservation strategy, and implementing Grizzly Bear management guidelines in areas of important habitat capability and known occurrence of Grizzly Bear.
Vanderhoof	20 area-specific RMZs	Under general management directions, the objective is to maintain or enhance Grizzly Bear populations and habitat by identifying and mapping of high suitability and capability Grizzly Bear habitat, by deactivating non-essential secondary roads and minimizing the amount and duration of new road access in high value habitats, and by managing for a mosaic of habitat types and characteristics.Further strategies for Grizzly Bear habitat management are made in some RMZs but are fairly generic, referring to inventory of habitats, maintenance of habitats, and "establishment of appropriate management plans."
Prince George	54 area-specific RMZs	Addressed in each area-specific RMZ. For example, within RMZ#1, the Parsnip High Elevation RMZ in the Special Resource Management Category-Natural Habitat, the objective is to "manage Grizzly Bear habitat to provide opportunity for population levels to increase" by identifying areas of high suitability and critical habitat where there will be access management planning with the intent of deactivating non-essential roads and minimizing the amount and duration of new roaded access, where the use of sheep in vegetation management will be avoided, where a mosaic of habitat types and characteristics and stand attributes that mimic habitat most suitable for Grizzly Bears, and where disturbance will be avoided to known Grizzly Bear denning sites.
Robson Valley	23 area-specific RMZs	General objective is to "maintain or enhance habitat and/or increase numbers, genetic variability, and distribution" through 9 strategies including identifying, conserving, and managing critical habitat in medium and historically high density bear zones, encouraging land use practices that promote the long-term viability of important forage species, managing road access, establishing Grizzly Bear management areas or other land use designations that benefit Grizzly Bear populations, ensuring the continued existence of adequate seasonal foraging sites with adjacent cover, minimizing bear displacement from preferred habitat by preventing habitat fragmentation, locating roads to avoid avalanche paths, leaving forest reserves of 100 m on each side of important avalanche paths, and timing human activities to avoid conflicts with concentrated seasonal bear use areas. Within individual RMZs, the above objective is repeated for wildlife with area-specific strategies on access and on reducing conflicts between Grizzly Bears and commercial recreation use, mining development, and range use.

Strategic land use plan	Type of resource management zone (RMZ)	Approach to Grizzly Bear habitat management *General or specific objectives or area-based direction for Grizzly Bear habitat management*
Kamloops	6 land use classes with smaller RMZs	Not addressed.
Okanagan-Shuswap	Resource-Use Specific RMZs which overlap with other RMZs	RMZs established for Grizzly Bear habitat management, which overlap with RMZs for other species or other land uses. The Grizzly Bear RMZ establishes (in much more detail than most other LRMPs) the locations of areas managed as Grizzly Bear habitat; and provisions for maintaining screening, security, and thermal cover adjacent to critical habitats. It also establishes how to maintain or enhance forage availability, cover, and connectivity; how to minimize negative interactions associated with access; and how to minimize negative interactions associated with commercial tourism and recreation developments.
Kootenay-Boundary LUP	RMZs are equivalent to forest districts	Addresses land use classes within RMZs by mapping Biodiversity Emphasis Zones, Connectivity Corridors, Enhanced RD Zones (Timber), Caribou Habitat Areas, and Areas managed for mature. The KBLUP-Implementation Strategy has only one objective relating to Grizzly Bear habitat: "To maintain Grizzly Bear habitat, retain adequate amounts of mature, and/or old forests, as determined through Objective 2, adjacent to important avalanche tracks."
Cariboo-Chilcotin LUP	3 resource development zones (RDZ)	Each RDZ is subdivided into areas for which the following clause, or a very close approximation, is included as resource targets: "To manage for Grizzly Bear, moose, furbearer, species at risk, and other sensitive habitats within the areas identified as riparian buffers, recreation areas, caribou habitat, and lakeshore management zones and throughout the polygon under the biodiversity conservation strategy."

Access

Where planning tables propose a conservation objective for Grizzly Bears, they should consider application of a variety of access management measures designed to ensure habitat security, prevent population fragmentation, minimize displacement from preferred habitat, and minimize mortality risk. Access management regimes should be applied over areas roughly equivalent to an average adult female home range, and the practices directed at ensuring adult female security and survival. Access management may include complete closure of roads, seasonal closure of roads, limiting access to commercial or industrial users only, or other access regimes designed to prevent displacement of Grizzly Bears from areas near roads.

Objectives should include provisions that maximize the net amount, quality, and seasonal representation of Grizzly Bear habitat that is >500 m from an open road (i.e., roads that receive any motorized use from 1 April to 31 October). Larger roadless areas (e.g., >1000 ha) are preferred. Wherever possible, retain these areas for at least 10 years. Similarly, objectives should include minimizing the amount of areas with >0.6 km/km^2 of open road (i.e., a road without restriction on motorized vehicle use) where these are in Grizzly Bear habitat. Consider also the following provisions:

- Promote one-side development (i.e., road construction and harvesting on one side of a valley at a time).
- Remove ballast from roads across avalanche chutes. Close permanent roads by removing bridges. Remove bridges when permanently deactivating roads. Revegetate temporary access (e.g., excavated or bladed trails), roads, and landings with non-forage species to minimize mortality risk of attracted bears.
- Minimize the impact of open roads on Grizzly Bears.
- Schedule forestry activities to avoid displacing bears from preferred habitat during periods of seasonal use.
- Provide windfirm visual screening along roads to provide security (i.e., do not conduct vegetation management or stand tending adjacent to roads).

Seral stage distribution

- Maintain or restore Grizzly Bear foraging opportunities and habitat effectiveness across the landscape and over time.
- Determine current and future forage values and habitat effectiveness of planning area. Landscapes with extensive areas of mid-seral forest characterized by closed canopies, conifer dominance, and high stocking levels have little Grizzly Bear habitat value. Similarly, suitable foraging habitat may not be effective (i.e., useable) because of the proximity to human settlement, transportation routes, agriculture, or other human activities or development. Current forage values and habitat effectiveness at the landscape level can be determined through interpretations of ecosystem maps (e.g., TEM, PEM, BEI) or other surrogate maps using the 6-class wildlife habitat mapping system (RIC 1999). Interpretations should assess habitat effectiveness that may be reduced in areas near human settlement or developments, agricultural areas, and roads. In addition, the type of disturbance that has created early seral habitats, and likely outcome of the type of disturbance should be assessed. For instance, logging and wildfire both produce early seral habitats that may be mapped similarly by ecosystem mapping, but can be very different in the amount of foraging potential for Grizzly Bears, and in the length of time this foraging potential will be available to Grizzly Bears.
- Where developments reduce the effectiveness of habitat within a landscape, where forest succession is reducing foraging values, or where restoration is an objective, consider management of early seral stages to recover effectiveness lost to development or to forest succession. Foraging habitat can be created by creating early seral habitats, but only if managed effectively for Grizzly Bear forage, and remain useable by Grizzly Bears.
- Manage landscapes for steady levels of early seral habitat to avoid "booming" and "busting" forage supply.

Silviculture

- Lower conifer stocking levels to provide Grizzly Bear forage.

- In NDTs 1–3, retain 50% of the largest pieces (top 20% diameter and length) of coarse woody debris in decay classes 1–2 for summer foraging on ants.
- Do not use broadcast vegetation management methods in capable watersheds, except where stand establishment or re-establishment is the objective and broadcast methods are required. Vegetation management methods, listed in increasing order of impact on Grizzly Bear forage are manual, chemical, cover crops, and sheep grazing.
- Do not use sheep, domestic goats, or cattle for vegetation management in occupied Grizzly Bear habitat to reduce direct and indirect conflicts with bears.

Range

- Consider establishing zones where range permits will be gradually removed and no new permits issued to reduce direct and indirect conflicts with Grizzly Bears. Use the effectiveness classes (based on BEI or finer-scale mapping interpreted for Grizzly Bear seasonal habitats with the application of habitat effectiveness from roads and human settlement) to decide where to limit grazing.

Restoration

- Conduct controlled burning to improve berry production (e.g., in ESSF).
- Plan for extended rotations to recover mature and old-growth characteristics such as more open canopies, greater amounts of understorey forage, and/or large trees (e.g., for rain interception in bedding habitat on coastal floodplains).
- Implement thinning and/or pruning to maintain open stands.
- Commercially thin to reopen closed canopies and recover productive shrub understories. Consider uneven spacing to maximize forage benefit.

Preventing human–bear conflict

- Maintain "attractant"-free main and fly-in camps (e.g., camps for tree planters, cruisers, engineers). Ensure adequate food storage and garbage management.

Wildlife habitat area

Goals

Protect known areas of concentrated seasonal use by Grizzly Bears.

Maintain the ecological integrity of important seasonal habitats.

Ensure the security of the bears using these habitats.

Feature

Establish WHAs for provincially significant areas, or for seasonally important habitats used by Grizzly Bears on a more local basis. Areas that are of provincial significance are those areas of known, consistently high, seasonal congregations of Grizzly Bears. Areas of seasonally important habitats may include salmon spawning areas where Grizzly Bears feed, herb-dominated avalanche tracks and run-out zones on southerly and westerly aspects, and known denning areas. On the coast, important seasonal habitats may also include estuaries, skunk cabbage swamps, and non-forested fen/marsh complexes. In the interior, seasonally important units may include herbaceous riparian meadow/wetland complexes, post-fire stands dominated by *Vaccinium* spp., subalpine parkland meadows, and *Hedysarum* and glacier lily complexes. Seasonally important habitats will be evaluated by Grizzly Bear Population Unit or subpopulation unit. In general, the subpopulation units are equivalent in size to landscape units.

In the absence of higher level plan direction, WHAs established within the provincial IWMS timber supply impact limit will only be established within threatened Grizzly Bear Population Units and Grizzly Bear Management Areas designated under the *Wildlife Act*, except for sites where there is no timber supply impact or the site is considered provincially significant (i.e., areas of known, consistently high, seasonal congregations) and recommended by the Director of the Biodiversity Branch, B.C. Ministry of Water, Land and Air Protection.

Size

WHAs will range from 1 to 500 ha but will ultimately depend on area of use, extent of seasonal habitat, and buffer size required to meet goals and objectives.

Design

When the main objective is to minimize disturbance around seasonal concentrations, consider the use of the area by Grizzly Bears and ensure the WHA includes a sufficient management zone to prevent disturbance. When the main objective of the WHA is to maintain seasonally important habitats, the WHA will be based on the extent of the seasonal habitat plus ~50 m but may vary with patch characteristics and objectives.

Use 6-class seasonal Grizzly Bear habitat capability and suitability mapping, where available, to identify seasonally important habitats (see RIC 1999). This assessment should be based on applying the Grizzly Bear densities associated with each capability class at the landscape scale (see Table 3). The result will be an estimate of the number of Grizzly Bears the area could potentially support in each season based on habitat suitability and capability. The season or seasons that would potentially support the lowest number of Grizzly Bears may be limiting or restricting the ability of the area to support Grizzly Bears. The highest suitability habitats within this limiting season(s) should then be considered priorities for protection through the establishment of WHAs depending on how restrictive the habitat "bottleneck" (i.e., limiting) may be and the habitat effectiveness of sites. Consideration should also be given to seasonal habitat effectiveness (e.g., an area may not be limited by the availability of suitable spring habitat; however, human activities disproportionately impact these habitats the area may be limited by the availability of effective spring habitat).

Otherwise use air photos, forest cover mapping, and any other appropriate sources of information combined with expert knowledge of Grizzly Bear habitat values and human impacts to qualitatively approximate the process described above.

General wildlife measures

Goals

1. Maintain ecological integrity of WHA.
2. Ensure security of Grizzly Bears within WHA by minimizing disturbance to bears within WHA.
3. Maintain Grizzly Bear forage values within WHA.
4. Minimize human-bear interactions.
5. Maintain windfirmness.

Table 3. Habitat capability and suitability classes and associated densities for Grizzly Bears*

Habitat capability or suitability class	Habitat capability or suitability range as % of provincial benchmark density	Grizzly Bear population density Minimum bears/ 1000 km²	Grizzly Bear population density Maximum bears/ 1000 km²
1 – Very High	76–100	76	100
2 – High	51–75	51	75
3 – Medium	26–50	26	50
4 – Low	6–25	6	25
5 – Very Low	1–5	1	5
6 – Nil	0	0	1

* These densities are suitable to use with 1:250,000+ scale mapping; relative densities should be applied to more detailed mapping.

Measures

Access

- Do not construct roads, trails, or landings.

Harvesting and silviculture

- No forestry practices should be carried out with the exception of treatments approved by the statutory decision maker to restore or enhance degraded habitat or to ensure windfirmness.

Pesticides

- Do not use pesticides.

Range

- Plan livestock grazing to maintain forage value for Grizzly Bears and minimize the potential for conflicts.
- Do not place livestock attractants within WHA.
- Incorporate management strategies in the range use plan to reduce contact and competition between livestock and Grizzly Bears. Consider salt placement, alternate water development, drift fencing, or altering periods of livestock use.

Additional Management Considerations

Ensure that Grizzly Bears do not have access to unnatural food sources (garbage) because of the consequent mortality risk.

Development around security and foraging WHAs should be managed to prevent disruption of natural influences of above- and below-surface drainage, shade, wind, and snow movement within the WHA.

Maintain livestock health.

Do not turn livestock out onto WHAs for Grizzly Bears during calving or lambing times.

Information Needs

1. Further development and application of techniques to monitor Grizzly Bear population and habitat trends.
2. Additional research on effects of human activities on Grizzly Bear habitat use (i.e., temporal response to access management).
3. Further development of techniques for assessing the impacts of proposed developments and land uses and for setting strategic objectives for Grizzly Bear habitat conditions.

Cross References

Bull Trout, Marbled Murrelet

References Cited

Archibald, W.R., R. Ellis, and A.N. Hamilton. 1987. Responses of Grizzly Bears to logging truck traffic in the Kimsquit River Valley, B.C. Int. Conf. Bear Res. and Manage. 7:251–257.

B.C. Ministry of Environment, Lands and Parks (MELP). 1995a. A future for the grizzly: British Columbia Grizzly Bear conservation strategy. Victoria, B.C.

______.1995b. Grizzly Bear conservation strategy: background report. Victoria, B.C.

Banci, V. 1991. Status report on the Grizzly Bear *Ursus arctos horribilis* in Canada. Committee on the Status of Endangered Wildl. in Canada, Ottawa, Ont.

Bunnell, F.L. and R.K. McCann. 1993. The Brown or Grizzly Bear. *In* Bears majestic creatures of the wild. Rodale Press. Emmaus, Penn. 240 p.

Ciarniello, L.M., J. Paczkowski, D. Heard, I. Ross, and D. Seip. 2001. Parsnip Grizzly Bear population and habitat project: 2000 progress report. Unpubl. report. Available from: http://web.unbc.ca/parsnip-grizzly/

Committee on the Status of Endangered Wildlife in Canada (COSEWIC). 2002. Canadian species at risk. Available from: http://www.speciesatrisk.gc.ca

Gibeau, M.L. and S. Herrero. 1998. Roads, rails, and Grizzly Bears in the Bow River Valley, Alberta. *In* Proc. Int. Conf. Ecology and Transportation. G.L. Evink (editor). Florida Dep. Transportation, Tallahassee, Fla., pp. 104–108.

Gyug, L.W. 1998. Forest development plan Blue-listed species inventory for mammals: assessment of Grizzly Bear populations, habitat use and timber harvest mitigation strategies in the North Cascades Grizzly Bear population unit, British Columbia. Report prepared for B.C. Environ., South. Interior Reg., Kamloops, B.C.

Hamilton, A.N. 1987. Classification of coastal Grizzly Bear habitat for forestry interpretations and the role of food in habitat use by coastal Grizzly Bears. M.Sc. thesis. Univ. B.C., Vancouver, B.C.

Havlick, D.G. 1998. Closing forest roads for habitat protection: a Northern Rockies case study. *In* Proc. Intl. Conf. Wildl. Ecol. and Transportation. G.L. Evink (editor). Florida Dep. Transportation, Tallahassee, Fla., pp.

Interagency Grizzly Bear Committee (IGBC). 1987. Grizzly Bear compendium. Natl. Wildl. Fed., Wash., D.C.

Kansas, J.L. 2002. Status of the Grizzly Bear (*Ursus arctos*) in Alberta. Alberta Sustainable Resour. Dev., Edmonton, Alta. Alberta Wildl. Status Rep. No. 37.

Mace, R.D., J.S. Waller, T.L. Manley, K. Ake, and W.T. Wittinger. 1999. Landscape evaluation of grizzly bear habitat in northwestern Montana. Conserv. Biol. 13(2):367–377.

Mace, R.D., J.S. Waller, T.L. Manley, L.J. Lyon, and H. Zuuring. 1996. Relationships among Grizzly Bears, roads and habitat in the Swan Mountains, Montana. J. Appl. Ecol. 33:1395–1404.

MacHutchon, A.G., S. Himmer, and C.A. Bryden. 1993. Khutzeymateen Valley Grizzly Bear study, final report. B.C. Min. Environ., Lands and Parks and B.C. Min. For., Victoria, B.C.

McLellan, B.N. 1981. Akamina-Kishinena Grizzly Bear project. Progress report 1980. B.C. Fish and Wildl. Br., Victoria, B.C. 88 p.

____. 1989a. Dynamics of a Grizzly Bear population during a period of industrial resource extraction. III. Natality and rate of increase. Can. J. Zool. 67(8):1865–1868.

____. 1990. Relationships between human industrial activity and Grizzly Bears. Int. Conf. Bear. Res. and Manage. 8:57–64.

McLellan, B.N. and F.W. Hovey. 1995. The diet of Grizzly Bears in the Flathead River drainage of southeastern British Columbia. Can. J. Zool. 73:704–712.

______. 2001. Natal dispersal of Grizzly Bears. Can. J. Zool. 79:838–844.

McLellan, B.N., F.W. Hovey, and J.G. Woods. 2000. Rates and causes of Grizzly Bear mortality in the interior mountains of western North America. *In* Proc. Conf. on the Biology and Management of Species and Habitats at Risk, Kamloops, B.C., Feb. 15–19, 1999. L. Darling (editor). B.C. Min. Environ., Lands and Parks, Victoria, B.C. and Univ. Coll. Cariboo, Kamloops, B.C., pp. 673–677.

McLellan, B.N. and D.M. Shackleton. 1988. Grizzly Bears and resource-extraction industries: effects of roads on behaviour, habitat use and demography. J. Appl. Ecol. 25(2):451–460.

Mattson, D.J. and M.M. Reid. 1991. Conservation of the Yellowstone Grizzly Bear. Conserv. Biol. 5:364–372.

NatureServe Explorer. 2002. An online encyclopedia of life [Web application]. Version 1.6. Arlington, Va. Available from: http://www.natureserve.org/explorer

Picton, H.D., D.M. Mattson, B.M. Blanchard, and R.R. Knight. 1985. Climate, carrying capacity and the Yellowstone Grizzly Bear. *In* Proc. Grizzly Bear Habitat Symp. G.P. Contreras and K.E. Evans (editors). U.S. Dep. Agric. For. Serv., Intermtn. Res. Stn., Ogden, Utah, Gen. Tech. Rep. INT-207, pp. 129–135.

Proctor, M. 2001. Grizzly bear habitat and population fragmentation in the Central Selkirk Mountains and surrounding region of southeast British Columbia. Unpubl. report. Available from: srmwww.gov.bc.ca/kor/wld/reports/pdf/SFP_Grizzly_DNA/SFP_Grizzly_DNA.pdf

Rausch, R.L. 1953. On the status of some arctic mammals. Arctic 6:91–148.

Resources Inventory Committee (RIC). 1999. BC wildlife habitat ratings standards. Version 2.0. B.C. Min. Environ., Lands and Parks, Victoria, B.C.

Russell, R.H., J. Nolan, N. Woody, and G. Anderson. 1979. A study of the Grizzly Bear in Jasper National Park 1975 to 1978. Report prepared for Parks Canada by Can. Wildl. Serv., Edmonton, Alta.

Servheen, C., J. Waller, and W. Kasworm. 1998. Fragmentation effects of high-speed highways on grizzly bear populations shared between the United States and Canada. *In* Proc. Int. Conf. Wildl. Ecol. and Transportation. G.L. Evink (editor). Florida Dep. Transportation, Tallahassee, Fla., pp. 97–10.

Simpson, K. 1987. Impacts of a hydro-electric reservoir on populations of caribou and Grizzly Bear in southern British Columbia. B.C. Min. Environ. and Parks, Nelson, B.C. Wildl. Work. Rep. WR-24.

Storer, T.I. and L.P. Trevis Jr. 1978. California Grizzly. Univ. Nebr. Press, Lincoln, Nebr. 335 pp.

Vroom, G.W., S. Herrero, and R.T. Ogilvie. 1977. The ecology of Grizzly Bear winter den sites in Banff National Park, Alberta. *In* 4th Int. Conf. on Bear Res. and Manage., Kalispell, Mont., Feb. 1977, pp.

Weaver, J.L., P.C. Paquet, and L.F. Ruggiero. 1996. Resilience and conservation of large carnivores in the Rocky Mountains. Conserv. Biol. 10:964–976.

White, D., Jr., K.C. Kendall, and H.D. Picton. 1998a. Grizzly Bear feeding activity at alpine army cutworm moth aggregation sites in northwest Montana. Can. J. Zool. 76(2):221–227.

______. 1998b. Potential energetic effects of mountain climbers on foraging Grizzly Bears. Wildl. Soc. Bull. 27(1):146–151.

Wielgus, R.B. 1986. Habitat ecology of the Grizzly Bear in the southern Rocky Mountains of Canada. M.Sc. thesis. Univ. Moscow, Idaho, . 136 p.

Zager, P., C. Jonkel, and J. Habeck. 1983. Logging and wildfire influence on Grizzly Bear habitat in northwestern Montana. Int. Conf. Bear Res. and Manage. 5:124–132.

KEEN'S LONG-EARED MYOTIS

Myotis keenii

Original[1] prepared by Trudy A. Chatwin

Species Information

Taxonomy

The Keen's Long-eared Myotis (*Myotis keenii*) is one of three long-eared bat "sister species." Differentiation between *M. keenii*, *M. evotis*, and *M. septentrionalis* is problematic. *Myotis keenii* formerly included its eastern sister taxon, but a study by van Zyll de Jong (1979) concluded that *M. septentrionalis* should be classified as a separate species. The two taxa were formally recognized by van Zyll de Jong (1985) and Jones et al. (1986). Van Zyll de Jong and Nagorsen (1994) analyzed specimens of *M. keenii* and *M. evotis* and found some morphological intermediates. However, based on distributions it was determined that these likely represent intraspecific variation and therefore the two were considered separate species. There are no recognized subspecies of *Myotis keenii*.

Description

Medium-sized (63–94 mm; 4–5.9 g) dark bat with paler underside. Ears and wing membranes are brown (not black). This species, like several other myotis species, have long ears and tragus. The Keen's Long-eared Myotis may be confused with the Western Long-eared Myotis (*Myotis evotis*) whose range overlaps that of the Keen's Long-eared Myotis. The two species can be reliably differentiated by analysis of skull measurements but cannot be distinguished with certainty in the field (see Nagorsen and Brigham 1993).

Distribution

Global

Restricted to the Pacific northwest coast. British Columbia is the centre of distribution but records exist from southeast Alaska and western Washington.

British Columbia

Occurs on Vancouver Island, the Queen Charlotte Islands, and the mainland coast.

Forest region and districts

Coast: Campbell River, Chilliwack, North Coast, North Island, Queen Charlotte Islands, South Island, Squamish, Sunshine Coast

Ecoprovinces and ecosections

GED: FRL, LIM, NAL

COM: CPR, KIM, KIR, NIM, NPR, NWL, OUF, QCL, SBR, SKP, SPR, WIM, WQC

Biogeoclimatic units

CDF: mm

CWH: dm, mm1, mm2, vm1, vm2, vh1, vh2, wh1, wh2, wm, wm1, wm2, xm1, xm2

MH: mm1, mm2, wh1, wh2

Broad ecosystem units

CD, CH, CW, FR, MF, RO, SR, YM

Elevation

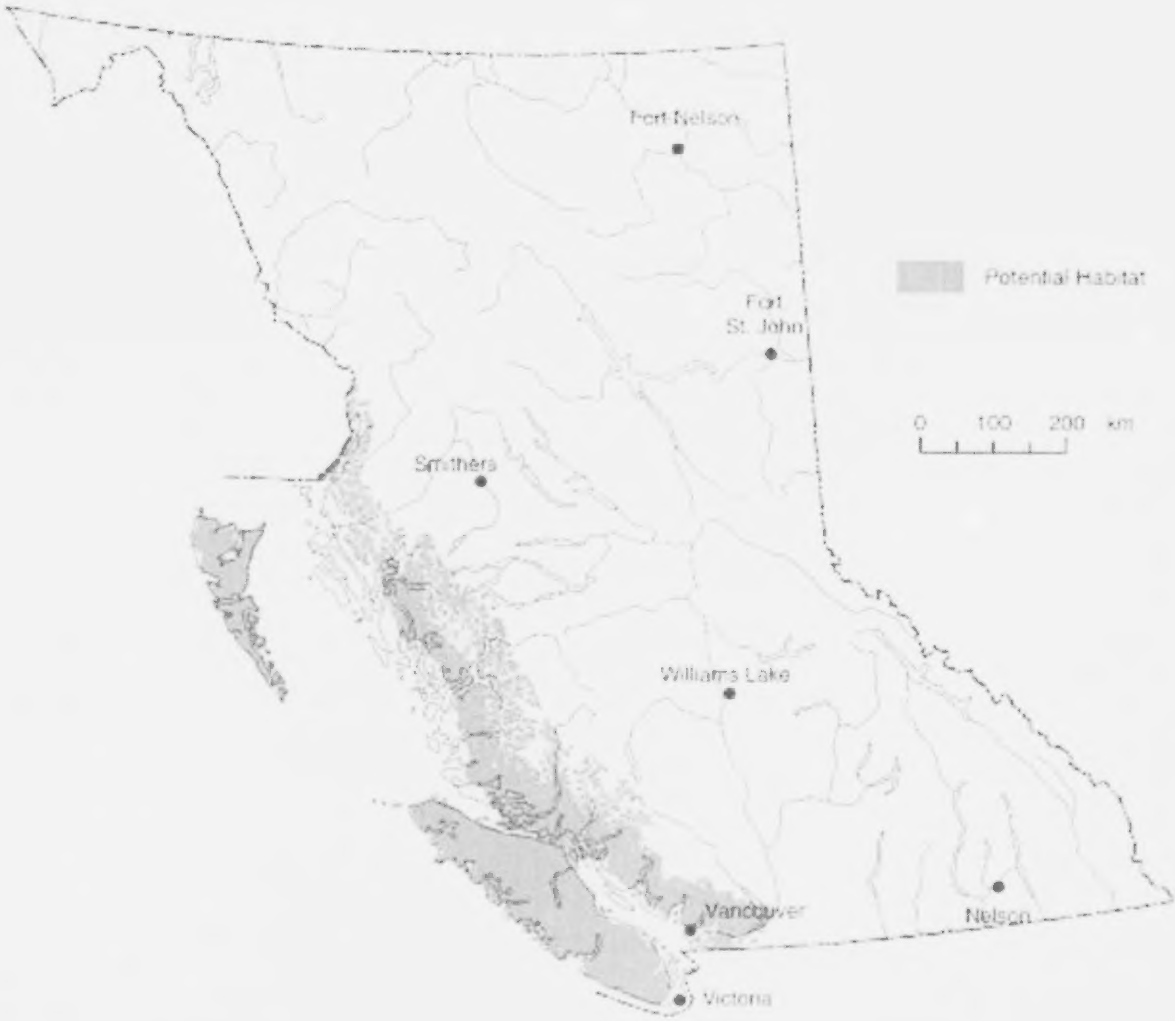
0–1100 m

---

[1] Volume 1 account prepared by P. Garcia and S. Rasheed.

Keen's Long-eared Myotis

(Myotis keenii)


Fort Nelson
Fort St. John
Potential Habitat
0 100 200 km
Smithers
Williams Lake
Vancouver
Nelson
Victoria

Note: This map represents a broad view of the distribution of potential habitat used by this species. The map is based on several ecosystem classifications (Ecoregion, Biogeoclimatic and Broad Ecosystem Inventory) as well as current knowledge of the species' habitat preferences. This species may or may not occur in all areas indicated.

Life History

Diet and foraging behaviour

Although foraging behaviour of this species is largely unknown, diet analysis from work in Gwaii Haanas National Park Reserve and southeast Alaska indicates that the main prey—in order of importance—are spiders, Tricopterans, moths, and flies (D. Burles, pers. comm.; Parker and Cook 1996). Parker and Cook (1996) suggest that this prey mixture of flying and non-flying arthropods points to a flexible feeding strategy of both pursuing prey in flight and gleaning and indicates that Keen's Long-eared Myotis is well adapted as an arthropod predator. Its small size, low wing-loading ratio, and very low intensity echolocation call makes it well adapted for flying and foraging within structurally complex old forest.

Reproduction

The Keen's Long-eared Myotis likely does not breed until its second summer. Mating occurs in the fall prior to hibernation. Fertilization is delayed until females leave the hibernacula in the following spring for maternity colonies. There is only one know maternity colony, consisting of at least 40 females, in British Columbia. It is located among geothermally heated boulders and crevices on Hotspring Island, Gwaii Haanas National Park. Females return to this colony in May. Young are born between early June to mid to late July (D. Burles, pers. comm.). Only one litter, usually a single pup, is produced per year.

Keen's Long-eared Myotis has been found roosting in southwest facing rock crevices, geothermally heated rocks, tree cavities, bark crevices, and even in buildings (D. Burles, pers. comm.; Firman et al. 1993; Nagorsen and Brigham 1993; Parker and Cook 1996; Mather et al. 2000). Maternity roosts and summer feeding occur at elevations below 240 m, while known hibernation sites occur over 400 m elevation in caves over 100 m long.

Site fidelity

There is little information on site fidelity of Keen's Long-eared Myotis. However, information collected from banded *Myotis* species show that other species of *Myotis* do show high site fidelity to maternity roost and hibernation sites. At the Gandl'kin maternity colony, two individuals that were banded in 1991 were recaptured near the same maternity roost in 1998.

Home range

Very little is known regarding the home range of Keen's Long-eared Myotis. From the very scant data, it appears that they may not move great distances in summer and may have small home ranges. The longest movement away from the capture site for three radio-tagged Keen's Long-eared Myotis tracked for 2–4 days in August 1999 was 1 km (Mather et al. 2000). Burles (pers. comm.) only captured Keen's Long-eared Myotis up to 500 m from the maternity roost.

Movements and dispersal

Although little is known about long-range movements, it appears that they leave the hibernaculum in May (Mather et al. 2000). At the Gandl'kin maternity colony some females arrive in mid-May, but the majority arrive at the end of May and remain at the colony after that time (D. Burles, pers. comm.). They abandon this maternity colony in mid- to late August.

Studies in British Columbia show that females seem to feed and raise young at low-elevations (<250 m) in summer. Low elevation ponds and riparian forests are warmer and have higher insect productivity. Males begin to visit and "swarm" at the cave hibernation sites in August. Females join the "swarming" males at the cave sites in September. *Myotis keenii* appears to go into hibernation in October (Mather et al. 2000)

Habitat

Structural stage

6: mature forest
7: old forest

Important habitats and habitat features

Keen's Long-eared Myotis appear to be associated with cool wet coastal montane forests and karst features.

Caves >100 m in length and above 500 m elevation are known to be important winter hibernation sites for myotis bats (Davis et al. 2000). Caves with stable temperatures between 2.4 and 4°C with a 100% relative humidity were important on northern Vancouver Island for myotis bats (Davies et al. 2000). In summer, rock faces and knolls with crevices that are solar or geothermally heated are important maternity roosts. The only known maternity colony is situated within geothermally heated rocks associated with hot spring activity. Tree cavities in wildlife trees (decay class 2 or greater) and loose bark (on trees with decay class 4 or greater) are important natural roost sites and may be limiting in some parts of their range. Low elevation coastal forest and riparian areas are important foraging areas.

Conservation and Management

Status

The Keen's Long-eared Myotis is on the provincial *Red List* in British Columbia. It is designated as a species of *Special Concern* in Canada (COSEWIC 2002).

Summary of ABI status in BC and adjacent jurisdictions (NatureServe Explorer 2002)

BC	AK	WA	Canada	Global
S1S3	SH	SH	N1N3	G2G3

Trends

Population trends

Population size and trends are not known (Cannings et al. 1999). At least 18 occurrences are known in British Columbia but more are likely to exist (Cannings et al. 1999). The only known maternity colony contains at least 40 adults.

In an inventory at Clayoquot Sound, long-eared bats comprised <10% of the captures. In a study at Weymer Cave on the west side of Vancouver Island, long-eared bats comprised 14.5% of the captures. On the Queen Charlotte Islands, captures of Keen's Long-eared Myotis were rare away from the maternity colony (D. Burles, pers. comm.).

Burles captured banded adults at Gandl'kin and determined that these Keen's Long-eared Myotis were at least 8 years old. The age at first breeding is not known but all females are capable of becoming pregnant after their first winter. In most bat species, females typically produce one offspring per year. It is likely that Keen's Long-eared Myotis have an even lower reproductive rate because the species occurs at northern latitudes in coastal montane habitats which can experience severe weather fluctuations during the breeding season. This may affect prey availability and consequently productivity. In 1999 at the Weymer Creek study, only two females captured showed signs of reproduction. Burles found no evidence of successful fledging in 1998 during a dry warm summer. In 1999, during a cooler summer, there was some evidence of fledging (D. Burles, pers. comm.).

Habitat

There is no information on habitat trends. However, it is generally accepted that wildlife trees, and summer and winter roosts are affected by logging and roadbuilding due to loss of habitat and disturbance. Therefore it may be assumed that habitat quality and quantity is generally declining.

Threats

Population trends

This species has a limited distribution and is considered sparsely distributed, which could increase its risk of extirpation or extinction.

Habitat

The main threat to the habitat of this species is forest harvesting and mineral extraction. Disturbance during hibernation and while raising young is a major concern. Disturbance may result from recreational activities (e.g., caving) or industrial activities (e.g., blasting for road construction).

Legal Protection and Habitat Conservation

Under the provincial *Wildlife Act,* the Keen's Long-eared Myotis is protected from killing, wounding, hunting or trapping, taking, and transporting including exporting and importing.

The only known maternity colony is protected within Gwaii Haanas National Park Reserve. One other known female and young roost site is managed within an existing WHA. Cave hibernation sites are also protected in Weymer Creek Provincial Park (305 ha). The Vancouver Island Land Use Plan increased the percentage of protected areas on Vancouver Island from 10.3 to 13%. At least one of these parks (White Ridge Provincial Park) may include suitable hibernacula, and Artlish Caves Provincial Park contains karst.

Results based code provisions that may provide habitat include old growth management areas and riparian provisions. Karst management guidelines under the results based code are under development.

Identified Wildlife Provisions

Wildlife habitat area

Goal

Protect known colonies (maternity or hibernacula) and roosting sites as well as their adjacent foraging areas and movement corridors (e.g., riparian areas).

Feature

Establish a WHA at known hibernacula, maternity colonies, and roosting sites.

Size

Typically between 30 and 50 ha but will depend on site-specific factores including the type of feature (cave vs. tree), location of roosting trees, presence of wetlands or lakes, and potential movement corridors.

Design

The WHA should include a 100 m radius core area and a 200 m radius management zone (total 300 m). When cave habitat is the focus of the WHA, the core area and management zone should be centred on the cave entrance(s). The WHA should also include a minimum 20 m core area on either side of any stream, wetland, or lake within 500 m of the site that is considered by MWLAP to be valuable bat habitat to include within the WHA.

General wildlife measures

Goals

1. Maintain microclimate conditions of the colony or roosting site.
2. Minimize disturbance during critical times (maternity sites: 15 May to 30 September; hibernaculum sites: 1 October to 31 May).
3. Maintain forage opportunities and night roosting habitat near colonies.
4. Maintain important structural features of the forest and karst ecosystem.

Measures

Access

- No road construction should be carried out within the core area.
- Do not remove rock or talus within core area or management zone.
- Do not blast within core area or management zone.

Harvesting and silviculture

- Do not harvest or salvage in core areas.

- Within maternity WHAs, do not harvest within the management zone from mid-May through September.
- Within hibernation WHAs, do not harvest within the management zone from October through May.
- Where harvesting is planned within the management zone, use partial harvesting systems that maintain a minimum of 70% basal area.
- When harvesting within the management zone, retain important structural elements specifically wildlife trees (decay classes 2–7) with cracks, peeling bark, cavities and hollow interiors, canopy gaps, and older green trees that have either cracks or crevices in thick bark, bark pulling away from the trunk forming crevices, or holes in the bole where limbs have been shed.

Pesticides

- Do not use pesticides.

Recreation

- Do not develop recreation facilities, sites, or trails.

Additional Management Recommendations

Any blasting within 1 km from the WHA cave entrance or maternity colony, should ensure that the peak particle velocity does not exceed 15 mm/sec. Sound concussion should be <150 decibels and the shock wave should be <1.5 p.s.i. (McQuarrie, pers. comm.).

Since karst areas, including limestone cliffs and caves, are important for this species they should be inventoried before development.

Restrict recreational use of caves during critical times.

Information Needs

1. Maternity roost characteristics and summer habitat use.
2. Measures of disturbance from blasting.
3. Location of hibernacula.

Cross References

Bull Trout, Coastal Tailed Frog, Fisher, Marbled Murrelet, Quatsino Cave Amphipod, "Queen Charlotte" Goshawk, Spotted Owl, "Vancouver Island" Common Water Shrew

References Cited

Cannings, S.G., L.R. Ramsay, D.F. Fraser, and M.A. Fraker. 1999. Rare amphibians, reptiles and mammals of British Columbia. B.C. Min. Environ., Lands and Parks, Wildl. Br. and Resour. Inventory Br., Victoria, B.C. 190 p.

Committee on the Status of Endangered Wildlife in Canada (COSEWIC). 2002. Canadian Species at Risk. www.speciesatrisk.gc.ca

Davis, M.J., A.D. Vanderberg, T.A. Chatwin, and M. Mather.2000. Bat usage of the Weymer Creek Cave Systems on northern Vancouver Island. *In* Proc. Conf. on the biology and management of species and habitats at risk. L.M. Darling (editor). Kamloops, B.C., Feb. 15–19, 1999. B.C. Min. Environ., Lands and Parks, Victoria, B.C., and Univ. Coll. Cariboo, Kamloops, B.C., pp. 305–312.

Firman, M., M. Getty, and R.M.R. Barclay. 1993. Status of Keen's long-eared Myotis in British Columbia. B.C. Min. Environ., Victoria, B.C. Wildl. Work. Rep. WR-59.

Jones, J.K., Jr., D.C. Carter, H.H. Genoways, R.S. Hoffmann, D.W. Rice, and C. Jones. 1986. Revised checklist of North American mammals north of Mexico, 1997. The Museum, Tex. Tech. Univ., Occ. Pap. 107:1–22.

Mather, M., T.A. Chatwin, and M. Davis. 2000. Bat usage of Weymer Creek Cave Systems on Vancouver Island. Report to Habitat Conserv. Trust Fund, Nanaimo, B.C. Unpubl.

Nagorsen, D.W. and R.M. Brigham. 1993. The bats of British Columbia. UBC Press, Vancouver, B.C.

NatureServe Explorer. 2002. An online encyclopaedia of life. Version 1.6. NatureServe. Arlington, VA. Available at http://www.natureserve.org/explorer/

Parker, D.I. and J.A. Cook. 1996. Keen's Long-eared Bat, *Myotis keenii,* confirmed in southeast Alaska. Can. Field Nat. 110:611–614.

van Zyll de Jong, C.G. 1979. Distribution and systematic relationships of long-eared myotis in western Canada. Can. J. Zool. 57:987–994.

______. 1985. Handbook of Canadian mammals. 2. Bats. Natl. Mus. Nat. Sci., Ottawa, Ont.

van Zyll de Jong, C.G. and D.W. Nagorsen. 1994. A review of the distribution and taxonomy of *Myotis keenii* and *Myotis evotis* in British Columbia and the adjacent United States. Can. J. Zool. 72:1069–1078.

Personal Communications

Burles, D.W. 2001. Gwaii Haanas National Park Reserve.

McQuarrie, E. 2001. Thurber Consulting Group, Victoria, B.C.

Winchester, N. 2001. Univ. of Victoria, Victoria, B.C.

PACIFIC WATER SHREW

Sorex bendirii

Original[1] prepared by Pontus Lindgren

Species Information

Taxonomy

Shrews belong to the Soricidae family, of which there are 13 species in Canada and nine species in British Columbia. The Pacific Water Shrew (*Sorex bendirii*), also referred to as the Marsh Shrew (Pattie 1973; Maser and Franklin 1974; Whitaker and Maser 1976; McComb et al. 1993) and Bendire's Shrew (Cowan and Guiguet 1973; Banfield 1974), has three subspecies, of which only *S. bendirii bendirii* is found in British Columbia.

Description

The Pacific Water Shrew is the largest shrew in the province (Nagorsen 1996) and the largest species of the *Sorex* genus in North America (Maser 1998). Nagorsen (1996) states that this shrew has an average length of 154 mm, of which 70 mm is tail, and weighs an average of 13.2 g. It has velvety dark chocolate brown fur that is only slightly paler on its ventral surface than its dorsal surface. The Pacific Water Shrew molts; however, the summer pelage is very similar in colour to the winter pelage (Banfield 1974). The tail is unicoloured and, like the body, is also dark brown. Adapted for its semi-aquatic lifestyle, it has a row of stiff fringe hairs on the toes of its hind feet. While submerged, this shrew maintains its body temperature with an insulating layer of air trapped within its fur, giving the shrew a silvery appearance while in the water (Calder 1969; Nagorsen 1996). In addition to being able to dive, air bubbles trapped beneath the feet provide enough buoyancy to enable this shrew to run on the surface of the water for up to 5 seconds. The Pacific Water Shrew is active during all hours of the day and throughout the year (Maser 1998).

The Common Water Shrew (*S. palustris*) is similar to the Pacific Water Shrew in several ways; it too is a large shrew, inhabits the Lower Mainland, lives close to water, has fringe hairs on its hind feet, can dive, and can run for short distances on top of water. However, within British Columbia, these shrews are often separated by elevation; the Common Water Shrew is usually found within habitats above 850 m while the Pacific Water Shrew typically inhabits areas below 850 m (Nagorsen 1996). Where these species do occur together, a Common Water Shrew can be distinguished by its bicoloured body and tail (dark above and pale below) which differs from the solid dark colouration of the Pacific Water Shrew.

Distribution

Global

The Pacific Water Shrew is found within the coastal lowlands of the Pacific Northwest, from northern California to southern British Columbia (Nagorsen 1996).

British Columbia

Within British Columbia, the Pacific Water Shrew is restricted to the extreme southwest corner, occupying the Lower Fraser Valley. It has been observed as far east as the Chilliwack River and Agassiz and as far north as the north shore of Burrard Inlet (Nagorsen 1996).

Forest regions and districts

Coast: Chilliwack, Squamish

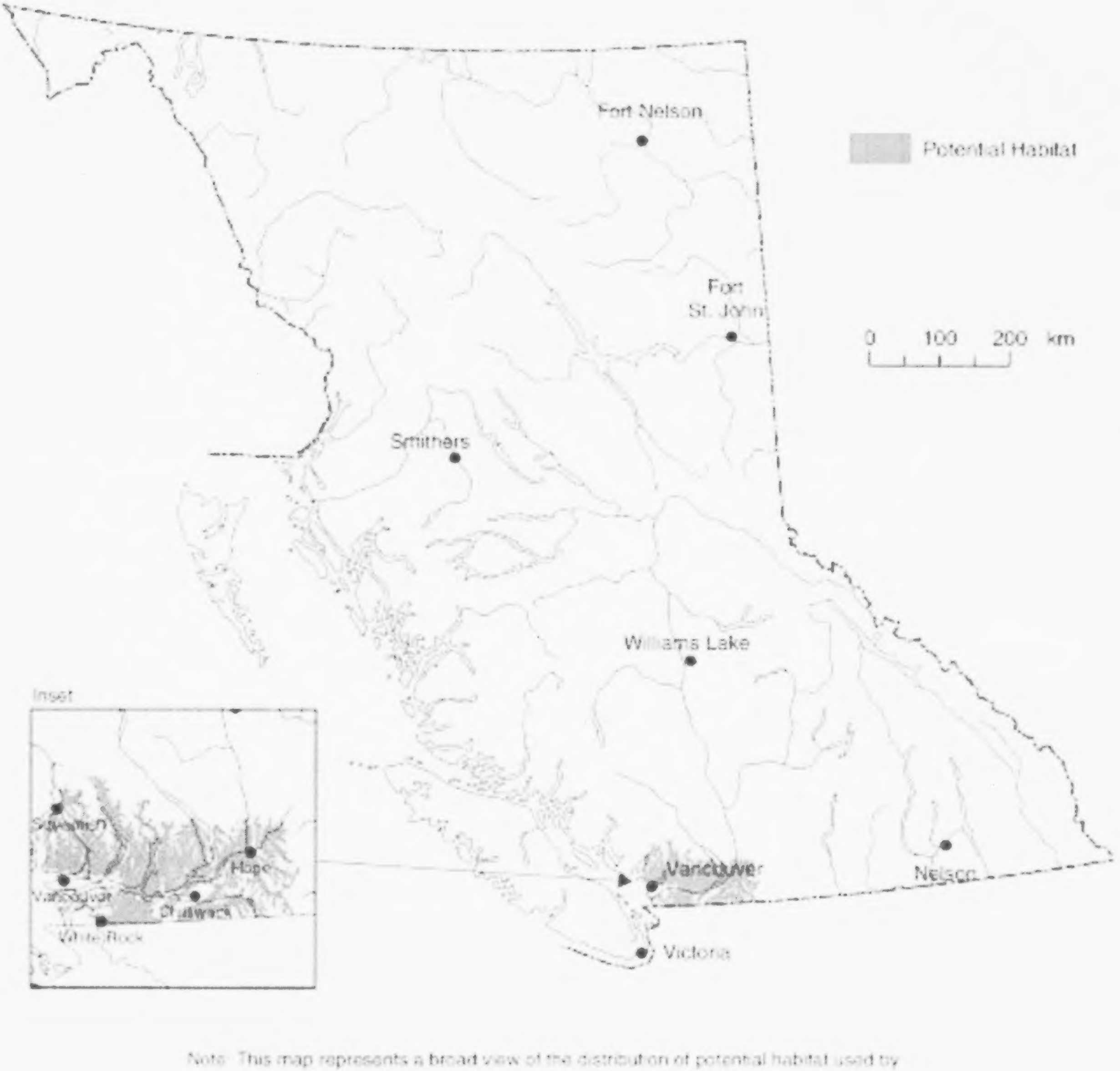
Ecoprovinces and ecosections

COM: EPR, SPR
GED: FRL

---

[1] Volume 1 account prepared by L. Darling and K. Paige.

Pacific Water Shrew
(Sorex bendirii)


Fort Nelson
▨ Potential Habitat
Fort St. John
0 100 200 km
Smithers
Williams Lake
Inset
Squamish
Hope
Vancouver
Chilliwack
White Rock
Vancouver
Nelson
Victoria

Note: This map represents a broad view of the distribution of potential habitat used by this species. The map is based on several ecosystem classifications (Ecoregion, Biogeoclimatic and Broad Ecosystem Inventory) as well as current knowledge of the species' habitat preferences. This species may or may not occur in all areas indicated.

Biogeoclimatic units

CDF: mm
CWH: dm, ds1, ms1, vm1, xm1

Broad ecosystem units

CD, CH, CR, CW, FR, RS, WL

Elevation

Up to 850 m but is generally believed to inhabit areas below 600 m (Nagorsen 1996)

Life History

Diet and foraging behaviour

All shrews are insectivorous. Whitaker and Maser (1976) reported the Pacific Water Shrew as the most specialized feeder of the five species of shrews studied in western Oregon, with 25% of stomach contents consisting of aquatic prey. Unidentified insect larvae, slugs, and snails, Ephemeroptera naiads, unidentified invertebrates, and earthworms were the foods most frequently consumed by this shrew. Pattie (1969) observed that captive shrews immobilize their prey with several rapid bites along the length of the body. Prey animals appear to be located by sound and by exploring the forest floor and rotten logs with their sensitive vibrissae (whiskers) and flexible snout. These tactile senses also appear to be used when locating prey animals under water. Dives for prey can last up to several minutes (Pattie 1969). Although prey will be seized underwater, food is always consumed on land.

Reproduction

Very little is known about the breeding biology of the Pacific Water Shrew and no studies have been conducted in British Columbia. In other parts of its range, young are born in March with an average litter size of three or four (Nagorsen 1996) and a gestation period of about 3 weeks (Beneski and Stinson 1987). These shrews likely do not become sexually mature until they have overwintered; however, females may mature during their first summer. The Pacific Water Shrew is an early breeder, with pregnant females captured as early as February (Beneski and Stinson 1987). A pungent odour originating from scent glands located on the flanks of males may function as a form of communication between sexes during the breeding season (Maser 1998). Shrews do not survive their second winter and may not survive their first (Nagorsen 1996). Pacific Water Shrews are assumed to survive only one overwinter period and have an average life expectancy of 18 months (Nagorsen 1996).

Home range

Very little is known about the home range size of the Pacific Water Shrew as removal methods used to sample this animal preclude such estimates. Harris (1984) reports a home range size of 1.09 ha; however, no sources for this estimate are provided.

Although a few Pacific Water Shrews have been captured considerable distances from water, probably related to juvenile dispersal (Maser and Franklin 1974), this shrew's affinity for slow-moving streams and marshes is well documented (Pattie 1973; Maser and Franklin 1974; Whitaker and Maser 1976; McComb et al. 1993; Zuleta and Galindo-Leal 1994; Nagorsen 1996; Maser 1998). In addition, both McComb et al. (1993) and Zuleta and Galindo-Leal (1994) report that capture rates are inversely related to distance from streams, and that most Pacific Water Shrews were found within 50 and 25 m of streams, respectively.

Movements and dispersal

Because of the removal methods used to sample the Pacific Water Shrew, very little can be said about the movements of this shrew. Young are assumed to disperse to suitable habitat after leaving the nest (Maser 1998).

Habitat

Structural stage

4: pole/sapling
5: young forest
6: mature forest
7: old forest

Important habitats and habitat features

Literature on habitat use by the Pacific Water Shrew is limited to only a few studies, most of which were conducted in Oregon and Washington. Two studies in Oregon report this shrew to be more abundant within mature and old forests (Corn and Bury 1991; Gilbert and Allwine 1991). Other studies in Washington describe this shrew to be equally, or more abundant, within young forests (Aubrey et al. 1991; West 1991). In a recent study conducted within the Lower Mainland, Zuleta and Galindo-Leal (1994) found three Pacific Water Shrews within widely separated habitats, ranging from deciduous to coniferous dominated sites with moderate to high canopy closure. It appears as though moist, coastal forests that border streams and skunk-cabbage marshes with an abundance of shrubs and coarse woody debris and extensive canopy closure are more important features than age of the forest (Nagorsen 1996). Likewise stream size may not be important but speed of water movement is likely important.

This semi-aquatic insectivore (25% of diet is aquatic invertebrates) requires access to slow-moving creeks and/or wetlands to forage. In addition to the aquatic food source, this shrew readily consumes terrestrial invertebrates found throughout the forest floor, especially within a well-developed litter layer and decomposed coarse woody debris. Forested riparian habitats typically provide both a well-developed forest floor as well as an abundant supply of coarse woody debris, making this habitat preferred foraging habitat for several species of insectivores (Nagorsen 1996).

Conservation and Management

Status

The Pacific Water Shrew is on the provincial *Red List* in British Columbia. It is considered *Threatened* in Canada (COSEWIC 2002).

Summary of ABI status in BC and adjacent jurisdictions (NatureServe Explorer 2002)

BC	WA	OR	CA	Canada	Global
S1S2	S5?	S4	S3S4	N1N2	G4

Trends

Population trends

Data on population trends of the Pacific Water Shrew are limited because of its rarity and the removal methods used for sampling this species. Although this species has probably never been abundant within any part of its global range, typically making up <1% of all small mammal captures (Aubrey et al. 1991; Corn and Bury 1991; Gilbert and Allwine 1991; West 1991), in British Columbia, fewer individuals have been documented recently than a century ago (Zuleta and Galindo-Leal 1994). Over the past 40 years, only 15 specimens have been collected and only eight extant occurrences have been identified, although more probably exist (Nagorsen 1996; CDC 2001). Because of the well-documented rarity of this shrew and the rapid degradation of critical riparian habitat resulting from urban sprawl and forestry operations throughout the Lower Mainland, the Pacific Water Shrew is undoubtedly experiencing a decline in population size within British Columbia (Galindo-Leal and Runciman 1994).

Habitat trends

Human developments, particularly urban and agricultural developments, have reduced or isolated much of the suitable riparian habitat for this shrew. During the past century, the aggregate channel length of small rivers and streams in Vancouver has been reduced from 120 to 20 km (Galindo-Leal and Runciman 1994). Approximately 15% of the streams in the Lower Fraser Valley have been lost and 71 % are considered threatened or endangered (Fisheries and Oceans Canada 1998). Additional habitat has likely been lost to industrial forest removal, although no studies have quantitatively assessed this type of development.

Threats

Population threats

Pacific Water Shrews are found in naturally low numbers (Aubrey et al. 1991; Corn and Bury 1991; Gilbert and Allwine 1991; West 1991), are habitat specialists (Nagorsen 1996), and within British Columbia, are found at their most northerly distribution (Zuleta and Galindo-Leal 1994). Consequently, this shrew is particularly vulnerable to the loss or isolation of its preferred riparian habitat. An indirect human-caused threat to the population may be increased predation by domestic cats. The impact of the increase in coyotes over the range of this species is not known.

Habitat threats

Urban and agricultural developments pose the most significant threat to the habitat and survival of the Pacific Water Shrew in British Columbia. The limited distribution of this shrew in British Columbia coincides with the largest urban centre in the province (Lower Mainland). The dissection of the Lower Mainland by roads, highways, and power lines has created a fragmented landscape of isolated habitat patches, which may not be large enough to support a viable population of Pacific Water Shrew (Galindo-Leal and Runciman 1994). Even when patches appear to be large enough, edge effects may render the habitat unsuitable for a habitat specialist like the Pacific Water Shrew. Examples of edge effects particularly detrimental to the habitat of this shrew are loss of canopy closure resulting in decreased security cover (Galindo-Leal and Runciman 1994; Nagorsen 1996); increased human-related disturbance, which can penetrate up to 70 m from an edge (Matlack 1993); and increased predation by domestic cats on small animals, of which 80% of captures are shrews (Fitzgerald 1988). Although some studies indicate that this shrew may be able to cope with edge effects (e.g., Zuleta and Galindo-Leal [1994] captured this shrew within isolated, small habitats, and one, 20 m from a busy public street), no studies have addressed the long-term consequences of edge effects on this species.

Forest harvesting has received little attention with respect to Pacific Water Shrew because most of this species range coincides with urban areas, not Crown land. However, industrial forest removal potentially threatens Pacific Water Shrew habitat in Canada because Pacific Water Shrews have been captured in several locations on or near Crown land (Galindo-Leal and Runciman 1994). These locations include the Chilliwack River Valley (four occurrences), Sumas Mountain (eight occurrences), and several watersheds located north of the Lower Mainland and Fraser River (Coquitlam River area, one occurrence; Seymour River area, four occurrences; Alouette River area, one occurrence).

Water quality is also of concern. Because this shrew spends a considerable amount of time foraging for aquatic invertebrates (Pattie 1969; Whitaker and Maser 1976), changes in water quality caused by agricultural runoff, residential septic fields, erosion, and industrial waste can have detrimental effects on its food source as well as the habitat of the Pacific Water Shrew (Galindo-Leal and Runciman 1994).

Legal Protection and Habitat Conservation

The Pacific Water Shrew is protected, in that it cannot be killed, collected, or held in captivity without special permits, under the provincial *Wildlife Act.*

Several occurrences are protected within regional and provincial parks including Mount Seymour Provincial Park (3508 ha), Cultus Lake Provincial Park (656 ha), Aldergrove Lake Regional Park (250 ha), and Pacific Spirit Regional Park (763 ha).

The results based code recommendations for biodiversity and riparian areas may conserve several beneficial attributes of Pacific Water Shrew habitat where implemented. Where landscape level planning can address maintenance of landscape connectivity, particularly along natural features such as streams and rivers, or can address natural vegetative species composition and requirements for coarse woody debris retention, then the recommendations may partially address this species requirements.

Riparian management recommendations may in some cases partially address the requirements of this species. Current riparian management recommendations for streams and wetlands vary depending on the size and classification of the aquatic feature. General recommendations include minimizing windthrow risk; maintaining wildlife trees; and conserving stream channel shape, bank stability, water quality, as well as guidelines for minimizing detrimental effects of range, roads, and culverts. Where these recommendations are applied they may contribute to the maintenance of this species' habitat.

Protected areas or special resource management zones created for other species overlapping in distribution with the Pacific Water Shrew (i.e., Spotted Owl, tall bugbane, Coastal Giant Salamander) may afford additional protection.

Although these habitat provisions provide several beneficial recommendations for the habitats of the Pacific Water Shrew, these provisions are not sufficient to ensure the conservation of this rare taxon. In addition the range of this species overlaps with private land.

Identified Wildlife Provisions

Sustainable resource management and planning recommendations

Landscape level planning within the Chilliwack and Squamish forest districts should promote connectivity among remnant patches of suitable low elevation riparian habitat by restoring forest habitat along watercourses and wetlands. Whenever possible, large buffer widths around riparian areas should be maintained to compensate for the fragmentation that is occurring.

Wildlife habitat area

Goal

Protect current and historical habitat of the Pacific Water Shrew.

Feature

Establish WHAs at current or historical sites where suitable habitat still exists.

Size

Generally between 5 and 45 ha but ultimately depends on the area of suitable habitat.

Design

It is recommended that the WHA extend the entire length of the stream or wetland and include at a 30 m core area and a 45 m management zone on each side of the stream or around wetland/wetland complex. Measurements of slope distance should be consistent with the *Riparian Management Area Guidebook*. Where slopes exceed 60%, the WHA should extend to the top of the inner gorge

The WHA should include suitable riparian and aquatic habitats. Wetlands, streams, or other suitable riparian habitats (e.g., Skunk-Cabbage marshes) within 1 km should also be included wherever possible to increase the effectiveness of the WHA. Because of the linear shape of the species home range, the management zone is necessary to minimize potential detrimental edge effects which tend to be more pronounced within long thin habitats.

General wildlife measures

Goals

1. Maintain hydrological regime.
2. Maintain water quality and physical integrity of riparian habitat.
3. Maintain or promote microclimate and structural elements known to be preferred by this species (i.e., good ground cover of evergreen shrubs, large amount of coarse woody debris, abundance of fine litter, and moderate to high levels of canopy closure from coniferous, deciduous, or mixedwood forests).
4. Minimize edge effects.

Measures

Access

- Do not construct roads unless there is no other practical option.

Harvesting and silviculture

- Do not harvest or salvage within the core area.

- Use partial-harvesting systems in the management zone that maintain 70% basal area. Partial harvesting within the management zone should promote natural microclimate and structural elements such as multi-layered canopies, wildlife trees, and coarse woody debris.
- Restrict activities that may alter the vegetation, hydrology, stream structure, or soils, particularly the upper soil layers.

Pesticides

- Do not use pesticides.

Recreation

- Do not establish recreational trails or sites within a WHA.

Additional Management Considerations

When operating immediately adjacent to WHAs, consider the following recommendations:

- apply as many of the silviculture practices required within the WHA management zone, particularly practices that minimize edge effects and promote the retention of the forest litter layer, coarse woody debris, and wildlife trees (future coarse woody debris);
- minimize impacts of forest activities by harvesting one side of a stream at a time;
- extend green-up specifications within riparian and nearby habitats to allow this area to better recover prior to harvesting adjacent areas;
- employ partial cutting systems to reduce edge effects near riparian areas; and
- incorporate larger riparian buffers.

Because of the rapid urban development that coincides with the distribution the Pacific Water Shrew in British Columbia, much of this shrew's habitat has been destroyed or fragmented (Galindo-Leal and Runciman 1994; Zuleta and Galindo-Leal 1994; Nagorsen 1996). It is important to consider this species within urban planning and stewardship programs.

Information Needs

1. Using live-trapping methods, determine basic demographic parameters (i.e., home range size, movement patterns, ability to recolonize areas) and a better understanding of habitat preferences and limitations are needed.
2. Effects of habitat fragmentation on this shrew, and investigating the impact of domestic cat predation.

Cross References

Bull Trout, Coastal Giant Salamander, Coastal Tailed Frog, Keen's Long-eared Myotis, Marbled Murrelet, Sandhill Crane, tall bugbane

References Cited

Aubrey, K.B., M.J. Crites, and S.D. West. 1991. Regional patterns of small mammal abundance and community composition in Oregon and Washington. *In* Wildlife and vegetation of unmanaged Douglas-fir forests. U.S. Dep. Agric. For. Serv., Gen. Tech. Rep. PNW-GTR-285, Portland, Oreg., pp. 285–294.

Banfield, A.W.F. 1974. The mammals of Canada. Natl. Mus. Nat. Sci., National Mus. Can., Univ. Toronto Press. 438 p.

Beneski, J.T. and D.W. Stinson. 1987. *Sorex palustris*. Am. Soc. Mammal. Mammalian Species No. 296.

B.C. Conservation Data Centre (CDC). 2001. Conservation status report and rare element occurrences for Pacific Water Shrew (*Sorex bendirii*) [online reports]. B.C. Min. Environ., Lands and Parks, Resour. Inv. Br., Victoria, B.C. Accessed March 14, 2001.

Calder, W.A. 1969. Temperature relations and underwater endurance of the smallest homeothermic diver, the Water Shrew. Comp. Biochem. Physiol. 30A:1075–1082.

Committee on the Status of Endangered Wildlife in Canada (COSEWIC). 2002. Canadian species at risk. Available from: http://www.speciesatrisk.gc.ca

Corn, P.S. and R.B. Bury. 1991. Small mammal communities in the Oregon Coast Range. *In* Wildlife and vegetation of unmanaged Douglas-fir forests. U.S. Dep. Agric. For. Serv., Gen. Tech. Rep. PNW-GTR-285, Portland, Oreg., pp. 241–256.

Cowan, I.McT. and C.J. Guiguet. 1973. The mammals of British Columbia. B.C. Prov. Mus., Victoria, B.C. Handb. 11:1–414.

Fisheries and Oceans Canada. 1998. Wild, threatened, endangered and lost streams of the Lower Fraser Valley. Summary Report. Report prepared for Fraser River Action Plan, Vancouver, B.C. 27 p.

Fitzgerald, B.M. 1988. Diet of domestic cats and their impact on prey populations. *In* The domestic cat: the biology and its behaviour. D.C. Turner and P. Bateson (editors). Cambridge Univ. Press, Cambridge, U.K., pp. 123–147.

Galindo-Leal, C. and J.B. Runciman. 1994. Status report on the Pacific water shrew (*Sorex bendirii*) in Canada. Committee on the Status of Endangered Wildl. in Canada, Ottawa, Ont.

Gilbert, F.F. and R. Allwine. 1991. Small mammal communities in the Oregon Cascade Range. *In* Wildlife and vegetation of unmanaged Douglas-fir forests. U.S. Dep. Agric. For. Serv., Gen. Tech. Rep. PNW-GTR-285, Portland, Oreg., pp. 257–268.

Harris, L.D. 1984. The fragmented forest: island biogeography and the preservation of biotic diversity. Univ. Chicago Press, Chicago, Ill. 211 p.

Maser, C. 1998. Mammals of the Pacific Northwest: from the Coast to the High Cascades. Oreg. State Univ. Press. Corvalis. 512 p.

Maser, C. and J.F. Franklin. 1974. Checklist of vertebrate animals of the Cascade Head Experimental Forest. U.S. Dep. Agric. For. Serv., Portland, Oreg. Res. Bull. PNW-51.

Matlack, G.R. 1993. Sociological edge effects: spatial distribution of human impact in suburban forest fragments. Environ. Manage. 17:829–835.

McComb, W.C., K. McGarigal, and R.G. Anthony. 1993. Small mammal and amphibian abundance in streamside and upslope habitats of mature Douglas-fir stands, western Oregon. Northwest Sci. 67:7–15.

Nagorsen, D.W. 1996. Opossums, shrews and moles of British Columbia. Royal B.C. Mus., Victoria, B.C.

NatureServe Explorer. 2002. An online encyclopedia of life [Web application]. Version 1.6. Arlington, Va. Available from: http://www.natureserve.org/explorer

Pattie, D. 1969. Behavior of captive Marsh Shrews (*Sorex bendirii*). Murrelet 50:28–32.

_____. 1973. *Sorex bendirii*. Am. Soc. Mammal. Mammalian Species No. 27.

West, S.D. 1991. Small mammal communities in the Southern Washington Cascade Range. In Wildlife and vegetation of unmanaged Douglas-fir forests. U.S. Dep. Agric. For. Serv., Gen. Tech. Rep. PNW-GTR-285, Portland, Oreg., pp. 269–284.

Whitaker, J.O., Jr. and C. Maser. 1976. Food habits of five western Oregon shrews. Northwest Sci. 50:102–107.

Zuleta, G.A. and C. Galindo-Leal. 1994. Distribution and abundance of four species of small mammals at risk in a fragmented landscape. B.C. Min. Environ., Lands and Parks, Victoria, B.C. Wildl. Work. Rep. WR-64.

Personal Communications

Sullivan, T.P. 2002. Applied Mammal Research Institute, Summerland, B.C.

SPOTTED BAT

Euderma maculatum

Original[1] prepared by Mike Sarell

Species Information

Taxonomy

The genus *Euderma* is monotypic and restricted to western North America (van Zyll de Jong 1985). There are no subspecies recognized.

Description

The Spotted Bat is a relatively large bat (wingspan of 35 cm, weight 18 g) and is very distinct from other bat species. It has enormous, pink ears and three white spots on its black back, one on each shoulder and one on the rump (van Zyll de Jong 1985). For a detailed description, see Nagorsen and Brigham (1993).

Distribution

Global

The Spotted Bat occurs in Mexico, California, Arizona, New Mexico, Colorado, Utah, Idaho, Montana, Oregon, Nevada, Texas, Washington, and British Columbia (Nagorsen and Brigham 1993; Sarell and McGuinness 1993). It has a somewhat discontinuous distribution across western North America which can be attributed to a lack of observations.

British Columbia

This species is restricted to dry interior valleys in British Columbia, which represent the northern extent of its global range. It occurs from the southern Okanagan Valley north to Williams Lake (Nagorsen and Brigham 1993; Holroyd et al. 1994) and west to Lillooet (Nagorsen and Brigham 1993). Spotted Bats appear to be absent east of the Okanagan Valley, despite similar climate and apparently suitable habitat (Sarell et al. 1998).

Forest regions and districts

Southern Interior: 100 Mile House, Cascades, Central Cariboo, Chilcotin, Kamloops, Okanagan Shuswap

Ecoprovinces and ecosections

CEI: CAB, CHP, FRB
SOI: NOB, NOH(?), OKR, PAR, SCR, SOB, STU, THB

Biogeoclimatic units

BG: xh1, xh2, xh3, xw2, xw3
IDF: dk(?), dm(?), mw(?), xh1a, xh1b, xh2a, xh2b, xw
PP: xh1, xh1a, xh2, xh2a

Broad ecosystem units

Roosting: BS, CL, RO, SS (DF, DP, PP – steep south facing slopes only)
Foraging: AB, BS, CF, CR, DF, DP, LL, LS, OV, PP, RO, SP, SS

Elevation

In British Columbia, Spotted Bats are found at elevations between 300 to 900 m, although most occurrences are below 500 m (Nagorsen and Brigham 1993). In other parts of its range, it has been found from sea level to 3300 m (Garcia et al. 1995).

Life History

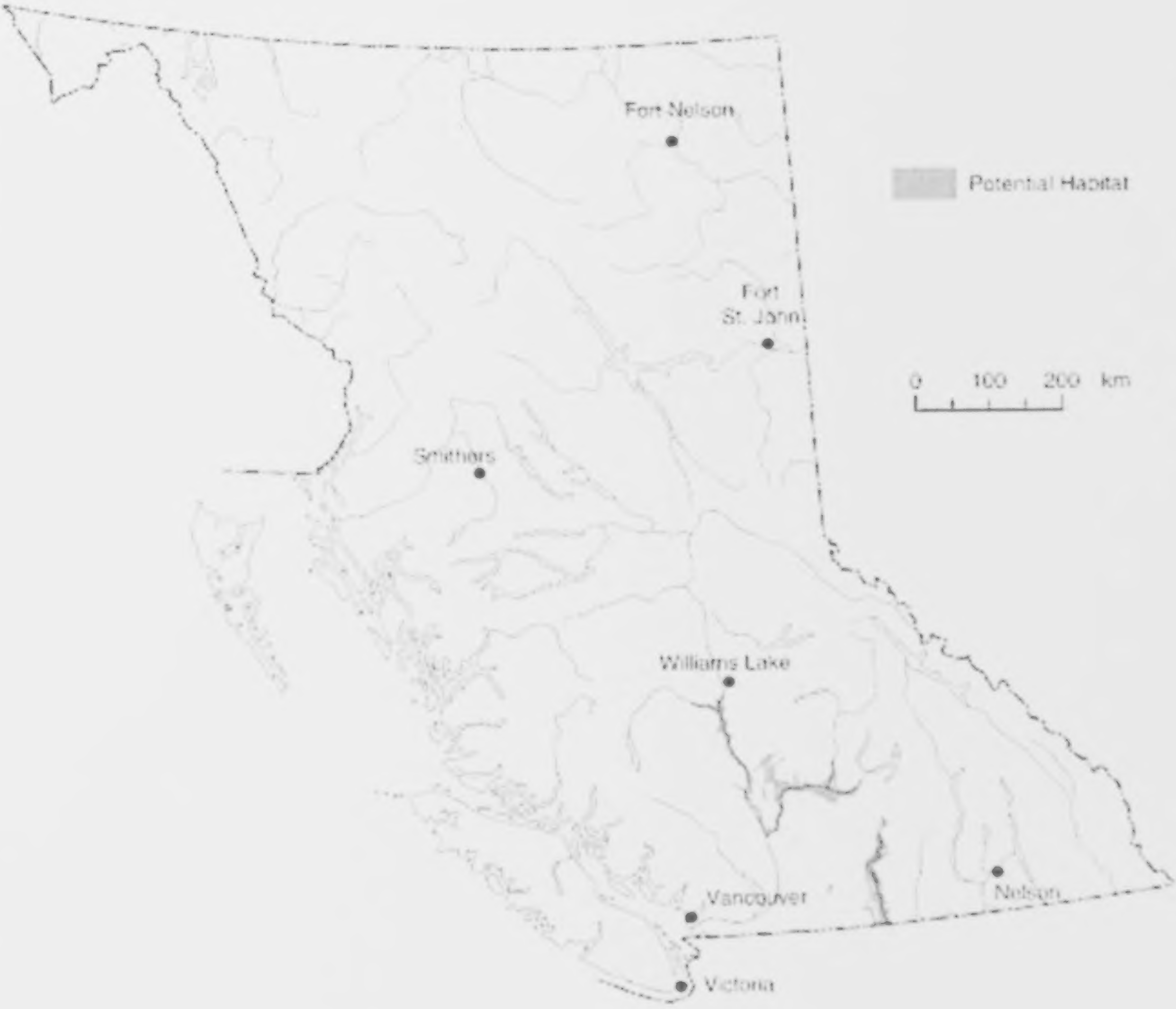
Diet and foraging behaviour

The Spotted Bat is an aerial insectivore and feeds almost exclusively on moths. Individuals maintain exclusive foraging areas when more than one individual is present in an area. Foraging takes place at heights of 5–15 m or higher, mostly over open ponderosa pine stands, fields, marshes, and riparian

---

[1] Draft account for Volume 1 prepared by S. Rasheed.

Spotted Bat
(Euderma maculatum)


Fort Nelson
Potential Habitat
Fort St. John
0 100 200 km
Smithers
Williams Lake
Vancouver
Nelson
Victoria

Note: This map represents a broad view of the distribution of potential habitat used by this species. The map is based on several ecosystem classifications (Ecoregion, Biogeoclimatic and Broad Ecosystem inventory) as well as current knowledge of the species' habitat preferences. This species may or may not occur in all areas indicated.

habitat. Night roosts are seldom used. These bats usually forage continuously on the wing except for briefly landing on cliffs or large, solitary pine trees.

Reproduction

Spotted Bats are believed to be solitary breeders (Balcombe 1988). It is suspected that Spotted Bats mate in the fall, like most other temperate bat species, and then delay fertilization until the following spring (Easterla 1973). A single young is born in late June or early July (Nagorsen and Brigham 1993) and become volant in late July (Sarell and Haney 2000). The low fecundity rate is offset by the probable longevity of the species, as most North American bats live for 10–30 years.

This bat is solitary and never encountered in colonies, although there is usually more than one bat inhabiting a cliff face but in separate roosts.

Site fidelity

Spotted Bats exhibit strong fidelity to roost cliffs and foraging circuits for much of the active season (Wai-Ping and Fenton 1989), although several roosts may be used during the active season (Sarell and Haney 2000). Hibernacula are unknown but Spotted Bats probably exhibit an even stronger fidelity to these sites as thermal and security requirements are paramount and unlikely to be widely available.

Home range

There are limited data on home ranges (Wai-Ping and Fenton 1989). Adults forage up to 10 km away from day roosts, suggesting home ranges of about 10 km^2. Home ranges overlap but conspecifics are avoided while foraging. Roosting is solitary yet cliffs may host many individuals, probably depending on the number of discreet roost features.

Movements and dispersal

Distances of up to 10 km (one way) between roost and feeding areas may be covered in a night. In the early summer, Spotted Bats exhibit both temporal and spatial predictability in their daily activity, using the same commuting routes, and feeding areas; they also return to the same 'day' roosts night after night. In the late summer, activity becomes less predictable and foraging and roosting habitat shifts may occur. Movements between roost sites are thought to be within their home ranges (Wai-Ping and Fenton 1989; Sarell and Haney 2000).

Habitat

Structural stage

There are no structural stage preferences known for this species, as they roost in large cliffs and often forage well above the canopy. Any influences on foraging from structural stage may be subtle and related to the production and availability of preferred prey.

Important habitats and habitat features

Roosting

The Spotted Bat is closely associated with rugged arid habitats. The availability of suitable cliffs and crevices may be limiting and may explain the discontinuous distribution of Spotted Bats. Steep, high cliffs within a few kilometres of suitable feeding areas (riparian areas, marshes, fields, grasslands, and open forest) and close to a source of water are important as day roosts (Collard 1991) and possibly as hibernation sites. Crevices within such cliffs must offer protection and a suitable thermal regime.

Day roosts are typically located in crevices in steep, tall cliffs. Individuals roost singly, although many individuals may roost in the same cliff (Sarell and Haney 2000). Several roosts may be used in a season, probably a result of seasonal weather changes or for reproductive requirements (Wai-Ping and Fenton 1989; Sarell and Haney 2000).

Foraging

Grassland, parkland, forest, wetland, and riparian areas provide abundant prey (Leonard and Fenton 1983; Wai-Ping and Fenton 1989). None of these habitats is known to be of greater value than the others (Navo et al. 1992). Foraging corridors, such as lake edges, may be used (Wai-Ping and Fenton 1989; Sarell and McGuinness 1993). These edges may act as navigation cues.

Wintering

No information is known about the winter habits of the Spotted Bat in BC and scant information is available for this species elsewhere in its range (Nagorsen et al. 1993). Early spring and late fall observations suggest that the species does hibernate near its summer range (Bryant 1989; Roberts and Roberts 1992; Sarell and Haney 2000). In more southerly parts of its range, Spotted Bats are thought to hibernate in the same location crevices as their summer roosts (Ruffner et al. 1979; Poche 1981). There is one unsubstantiated record (1930) of four individuals hibernating in a cave in Utah (Hardy 1941).

Conservation and Management

Status

The Spotted Bat is on the provincial *Blue List* in British Columbia. It is designated as a species of *Special Concern* in Canada (COSEWIC 2002).

Summary of ABI status in BC and adjacent jurisdictions (NatureServe Explorer 2002)

BC	ID	WA	Canada	Global
S3	S2	S3	N3	G4

Trends

Population trends

Spotted Bats were not detected in British Columbia until 1976. The population is estimated to be at least 200 individuals but many areas have not yet been surveyed; however, the population is considered small (Cannings et al. 1999). A recent study in the south Okanagan (Sarell and Haney 2000) suggests that there have been no significant changes in the population of Spotted Bats over the last two decades. There have not been similar studies conducted elsewhere in the province. Several Spotted Bats have been found dead or dying throughout the province (Okanagan Falls, Vaseux Lake, Salmon Arm, and Lower Nicola) although no association has been inferred between these mortalities.

Habitat trends

Roosting habitat is fairly secure from physical disturbances as cliffs are rarely altered, other than the natural sloughing of colluvium. Exceptions in British Columbia have occurred where rock-climbing routes have been established (Sarell et al. 1996) and where talus extraction occurs. Some roosts are now protected by the establishment of conservation holdings, particularly in the core of their range in the south Okanagan (Sarell and Haney 2000).

Foraging habitats are much more prone to disturbances and the alteration of these habitats from urbanization, agriculture, logging, and fire suppression may affect foraging behaviour and prey capture success.

Threats

Population threats

Although its range is widespread across western North America, the Spotted Bat is rarely abundant and individual populations appear disjunct. This is especially true of the Thompson and Fraser Canyon populations. Populations are most susceptible to declines from prolonged disturbances at, or near roosts. Spotted Bats seem to be one of the bats most affected by disturbances (e.g., physical harassment, noise, vibration) and have abandoned roost sites when disturbed (O'Farrell 1975).

Pesticide use may cause reductions or contamination of prey items (Balcombe 1988). Because spotted bats are insectivorous they may be sensitive to bio-amplification of insecticides (Balcombe 1988).

Habitat threats

Cliffs used as night roosts can be affected by rock climbing, lighting, road construction and road traffic, flooding from dam construction, and mineral extraction. Urbanization is the primary factor in the loss of foraging habitat as extensively lit areas are avoided. Timber harvesting may cause disturbances leading to roost abandonment if in the immediate proximity of the roost. Road construction and the subsequent traffic, especially at night, may also interrupt foraging behaviour. Water sources are important and in short supply in arid environments.

Legal Protection and Habitat Conservation

The Spotted Bat is protected, in that it cannot be killed, collected, or held in captivity without special permits, under the provincial *Wildlife Act.*

Several important roost sites are located in parks (Vaseux Bighorn National Wildlife Area, Haynes Lease Ecological Reserve) and other conservation holdings managed by the Canadian Wildlife Service and The Nature Trust of BC (McIntyre Bluff). Many roosts are located within provincial forests, Indian reserves, and private lands.

Until the recent designation of two grassland parks, only 5% (8340 ha) of suitable Spotted Bat habitat in the south Okanagan was designated as conservation lands, and 43% (67 384 ha) was found on provincial Crown land (MELP 1998). The remaining habitat is on Indian Reserves or private land.

The wildlife habitat feature designation under the results based code could be used to address the roosting habitat requirements of this species. Riparian management, landscape level planning and range use plans may address foraging habitats of this species.

Identified Wildlife Provisions

Sustainable resource management and planning recommendations

- Provide adequate representation of foraging habitat near roosting habitat.

Wildlife habitat area

Goal

Maintain roosting sites and foraging habitats.

Feature

Establish WHAs at known or likely roost sites and hibernacula if discovered.

Size

The size of the WHA should be related to the size of the roost feature (e.g., cliff face). It is expected that most WHAs will be about 5–10 ha but larger ones may be required at exceptional sites.

Design

The core of the WHA will consist of the roost cliff and talus base. The management zone should be 100 m around the roost cliff.

General wildlife measures

Goals

1. Minimize access.
2. Minimize disturbance, including audible or vibration disturbances, during critical times.
3. Maintain all known roosting sites and hibernacula.
4. Maintain foraging habitat and prey abundance.
5. Maintain suitable microclimatic regime for roosting and hibernating sites.
6. Maintain riparian areas in a properly functioning condition.

Measures

Access

- Do not develop roads. Avoid construction between March and October when bats are active. Rehabilitate temporary access roads immediately after use and use access control measures on roads that are required for operations.
- Do not remove rock or talus.

Harvesting and silviculture

- Do not harvest within the core area. Use selective harvest methods in the management zone. Retain veteran trees.

Pesticides

- Do not use pesticides.

Range

- Plan livestock grazing to meet GWM goals.
- Do not place livestock attractants within WHA.

Recreation

- Do not establish recreation sites or facilities within WHA.

Additional Management Considerations

Minimize impacts from recreational activities (i.e., rock climbing).

Information Needs

1. Further inventories for roost cliffs.
2. Location of hibernacula.

Cross References

Bighorn Sheep, Fringed Myotis, Prairie Falcon

References Cited

Balcombe, J.P. 1988. Status report on the Spotted Bat (*Euderma maculatum*) in Canada. Report prepared for the Committee on the Status of Endangered Wildlife in Canada, Ottawa, Ont. Unpubl.

B.C. Ministry of Environment, Lands and Parks (MELP). 1998. Habitat atlas for wildlife at risk: South Okanagan & Lower Similkameen. Penticton, B.C.

Bryant, A.A. 1989. Late fall monitoring of spotted bats (*Euderma maculatum*) in the south Okanagan Valley. Prepared for the B.C. Habitat Conserv. Fund and B.C. Environ., Penticton, B.C.

Cannings, S.G., L.R. Ramsay, D.F. Fraser, and M.A. Fraker. 1999. Rare amphibians, reptiles and mammals of British Columbia. B.C. Min. Environ., Lands and Parks, Wildl. Br. and Resour. Inv. Br., Victoria, B.C. 198 p.

Collard, T.S. 1991. Identification of the status and critical habitats of the Spotted Bat (*Euderma maculatum*), in the South Okanagan Valley, British Columbia. B.C. Min. Environ., Victoria, B.C. Unpubl.

Committee on the Status of Endangered Wildlife in Canada (COSEWIC). 2002. Canadian species at risk. Available from: http://www.speciesatrisk.gc.ca

Easterla, D.A. 1973. Ecology of the 18 species of Chiroptera at Big Bend National Park, Texas. Northwest Missouri State Univ. Stud. 34(2–3): 1–165.

Garcia, P.F.J., S.A. Rasheed, and S.L. Holroyd. 1995. Status of the spotted bat in British Columbia. B.C. Min. Environ., Lands and Parks, Wildl. Br., Victoria, B.C. Wildl. Work. Rep. No. WR-75.

Hardy, R. 1941. Some notes on Utah bats. J. Mammal. 2:289–295.

Holroyd, S.L., R.M.R. Barclay, L.M. Merk, and R.M. Brigham. 1994. A survey of the bat fauna of the dry interior of British Columbia: a summary by species with recommendations for future work. B.C. Min. Environ. Victoria, B.C.Wildl. Work. Rep. No. WR-63.

Leonard, M.L. and M.B. Fenton. 1983. Habitat use by spotted bats (*Euderma maculatum*) (Chiroptera: Vespertilionidae): roosting and foraging behaviour. Can. J. Zool. 61(7):1487–1491.

Nagorsen, D.W. and R.M. Brigham. 1993. The bats of British Columbia. Univ. B.C. Press, Vancouver, B.C. 164 p.

Nagorsen, D.W., A.A. Bryant, D. Kerridge, G. Roberts, A. Roberts, and M.J. Sarell. 1993. Winter bat records for British Columbia. Northwest Nat. 74:61–66.

NatureServe Explorer. 2002. An online encyclopedia of life [Web application]. Version 1.6. Arlington, Va. Available from: http://www.natureserve.org/explorer

Navo, K.W., J.A. Gore, and G.T. Skiba. 1992. Observations on the Spotted Bat (*Euderma maculatum*) in northwestern Colorado. J. Mammal. 73(3):547–551.

O'Farrell, M.J. 1975. Status report: *Euderma maculatum* (J.A. Allen). U.S. Fish and Wildl. Serv., Office of Endangered Species, Albuquerque, N. Mex. 29 p.

Poche, R.M. 1981. Ecology of the spotted bat (*Euderma maculatum*) in southwest Utah. Utah Div. Wildl. Resour., Publ. No. 81-1. 63 p.

Roberts, G. and A. Roberts. 1992. Grassland biodiversity in the Chilcotin Bunchgrass subzones and adjacent Douglas-fir subzone. B.C. Environ. and B.C. Habitat Conserv. Fund, Victoria, B.C. 63 p. Unpubl.

Ruffner, G.A., R.M. Poche, M. Meierkord, and J.A. Neal. 1979. Winter bat activity over a desert wash in southwestern Utah. Southwest. Nat. 24:447–453.

Sarell, M.J. and A. Haney. 2000. South Okanagan rare bat survey 2000. B.C. Environ., Penticton, B.C. 79 p. Unpubl.

Sarell, M.J., A. Haney, and S. Robertson. 1998. Inventory of Red and Blue-listed wildlife within the southern Boundary Forest District. Forest Renewal BC and B.C. Environ., Penticton, B.C. Unpubl.

Sarell, M.J. and K.P. McGuinness. 1993. Rare bats of the shrub-steppe ecosystem of eastern Washington. Wash. Dep. Wildl., Olympia, Wash. Gen. Tech. Rep. 23 p.

Sarell, M.J., S. Robertson, and L. Scott. 1996. Skaha Bluffs wildlife inventory: amphibians, snakes and bats. Habitat Conserv. Trust Fund and B.C. Environ., Penticton, B.C. Unpubl.

van Zyll de Jong, C.G. 1985. Handbook of Canadian mammals. 2. Bats. Natl. Mus. Nat. Sci., Ottawa, Ont. 212 p.

Wai-Ping, V. and M.B. Fenton. 1989. Ecology of Spotted Bat (*Euderma maculatum*) roosting and foraging behaviour. J. Mammal. 70(3):617–622.

VANCOUVER ISLAND MARMOT

Marmota vancouverensis

Original[1] prepared by Andrew A. Bryant

Species Information

Taxonomy

The Vancouver Island Marmot, *Marmota vancouverensis* (Swarth 1911), is endemic to Vancouver Island and is the only member of the genus *Marmota* that occurs there (Nagorsen 1987). Five other species of marmot occur in North America: the Woodchuck, *M. monax;* Hoary Marmot, *M. caligata;* Yellow-bellied Marmot, *M. flaviventris;* Olympic Marmot, *M. olympus;* and Brower's Marmot, *M. browerii*). Worldwide, 14 species are recognized (Barash 1989).

Marmota vancouverensis was described from 12 specimens shot on Douglas Peak and Mount McQuillan in central Vancouver Island in 1910 (Swarth 1912). *Marmota vancouverensis* is considered a "true" species on the basis of karyotype (Rausch and Rausch 1971), cranial-morphometric characteristics (Hoffman et al. 1979), and reproductive isolation from Hoary (*M. caligata*) and Olympic (*M. olympus*) marmots on the North American mainland (Nagorsen 1987). *Marmota vancouverensis* differs from the closely related Hoary and Olympic marmots in colour (Hoffman et al. 1979) and behaviour (Heard 1977). Recently published DNA phylogenies suggest relatively recent divergence in the three species (Kruckenhauser et al. 1999; Steppan et al. 1999).

Description

Fur colour is diagnostic. Vancouver Island marmots have a rich chocolate-brown coat with contrasting patches of white fur on the nose, chin, forehead, and chest. Pups (young-of-the-year) have uniformly dark, almost black, coats. As summer progresses the fur fades to a more rusty, rufous colour. Unlike most mammals, Vancouver Island Marmots apparently do not complete their molt every year. For this reason yearlings are typically a uniform faded rusty colour in June and 2 year olds have dark fur. Older animals can take on a decidedly mottled appearance, with patches of old, faded fur contrasting with new, dark fur.

Marmots have large, beaver-like incisors, sharp claws, and very powerful shoulder and leg muscles. Adults typically measure 65–70 cm from nose to tip of the tail. Weights show large seasonal variation. An adult female that weighs 3 kg when she emerges from hibernation in late April can weigh 4.5–5.5 kg by the onset of hibernation in mid-September. Adult males can be even larger, reaching weights of up to 7 kg. Marmots generally lose about one-third of their body mass during winter hibernation.

Distribution

Global

The Vancouver Island Marmot is one of only five mammal species considered endemic to Canada (Wilson and Reeder 1993).

British Columbia

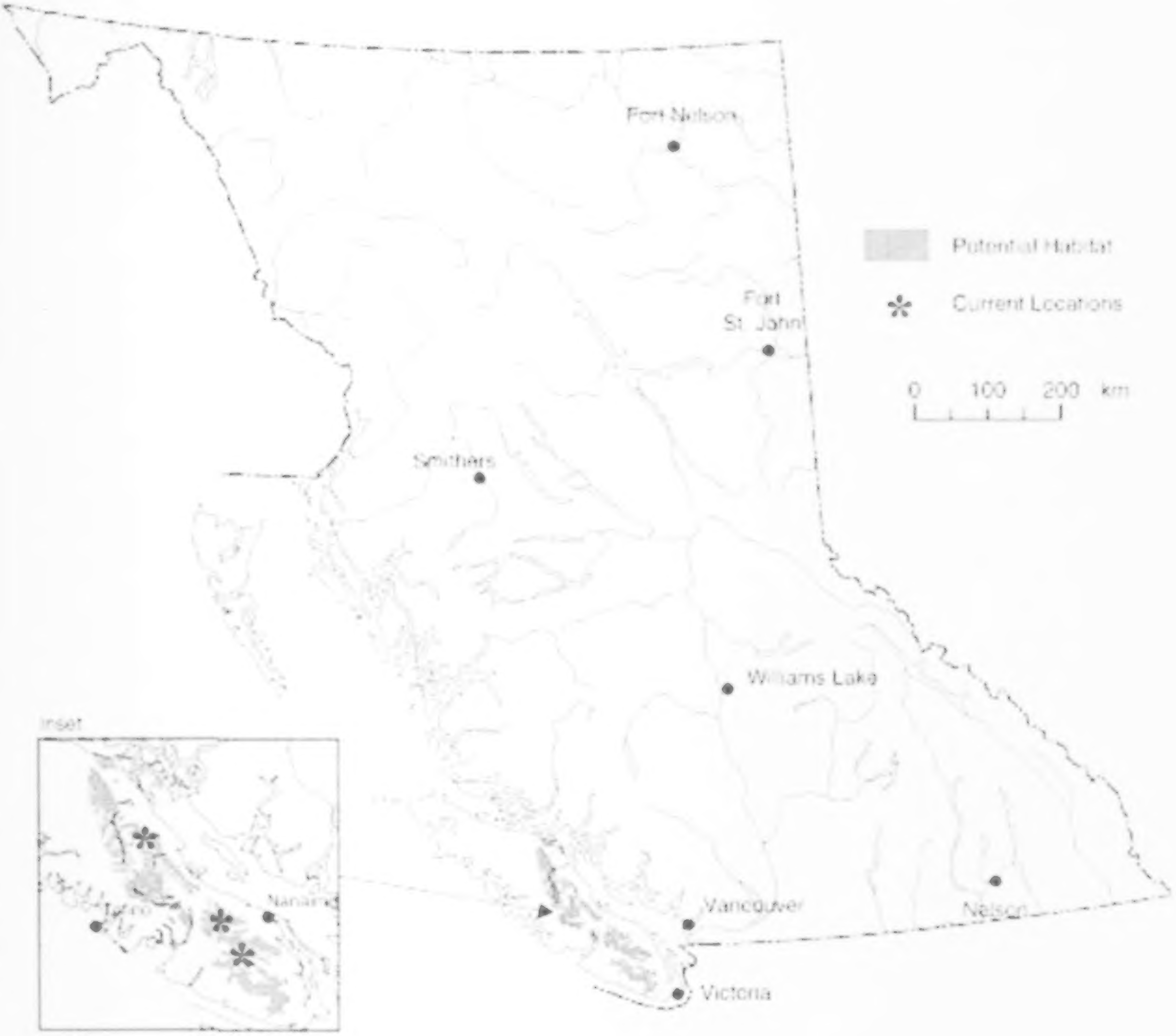
The distribution is now highly restricted on Vancouver Island. Most of the few remaining marmot colonies occur in south-central Vancouver Island at the headwaters of the adjacent drainages of the Nanaimo, Chemainus, Nitinat, Cameron, and Cowichan rivers. One small isolated colony occurs on Mount Washington in east-central Vancouver Island. The recent historical range (from 1864 to 1969) was apparently considerably broader, including records from at least 25 mountains on the leeward spine of Vancouver Island (Bryant and Janz 1996). In addition there are five additional known prehistoric location records (Nagorsen et al. 1996).

---

[1] Volume 1 account prepared by B. Forbes and L. Hartman.

Vancouver Island Marmot

(Marmota vancouverensis)



Fort Nelson
Fort St. John
Smithers
Williams Lake
Vancouver
Victoria
Nelson
Inset
Tofino
Nanaimo
Potential Habitat
Current Locations
0 100 200 km

Note: This map represents a broad view of the distribution of potential habitat used by this species. The map is based on several ecosystem classifications (Ecoregion, Biogeoclimatic and Broad Ecosystem Inventory) as well as current knowledge of the species' habitat preferences. This species may or may not occur in all areas indicated.

Forest region and districts

Coast: Campbell River, South Island

Ecoprovinces and ecosections

GED: LIM

Biogeoclimatic units

AT:
CWH: mm2
MH: mm1, mmp1

Broad ecosystem units

AV, FR, SM, TA

Elevation

800–1600 m (natural colonies); 700–1200 m (clearcuts)

Life History

Diet and foraging behaviour

Vancouver Island marmots are herbivorous. Martell and Milko (1986) used fecal samples from three natural subalpine colonies to identify food plants. They concluded that marmots depend on oatgrass (*Danthonia intermedia*) and sedges (*Carex* spp.) in early spring, and shift to forbs (especially *Lupinus latifolius* and *Eriophyllum lanatum*) in summer and fall. Spreading phlox (*Phlox diffusa*) is apparently an important food item in early summer. Similar work has not been conducted at other colonies; however, known food plants at clearcut sites include grasses, *Anaphalis margariticea*, *Fragaria* spp., *Epilobium angustifolium*, and *Lupinus latifolius* (Bryant, unpubl. data).

Typical Vancouver Island Marmot behaviour involves spending much of the day resting on boulders, logs, or stumps. Relatively little time is spent feeding. Marmots are more likely to be seen in early morning or late afternoon than during the middle of the day.

Reproduction

Vancouver Island Marmots are slow to achieve sexual maturity. Most males and females do not breed until 4 years old, although two females are known to have bred when 2 years old. In most cases there is a non-reproductive interval of at least 1 year between litters. Mating occurs within several weeks of emergence in the spring. Gestation is approximately 31 days. Most litters are three or four pups; litters of two, five and six occur infrequently. Pups are born blind and hairless and remain underground for approximately 1 month. Young have been observed above ground as early as 22 June but the bulk of litters emerge from 28 June through 7 July (Bryant 1998).

Site fidelity

Marmot pups and adults predictably use the same burrows and adjacent meadows and cliffs from year to year. Natal and hibernation burrows are often reused in consecutive years, as are escape burrows and "lookout" boulders or stumps (Bryant 1998). This consistent use allows easy detection of marmots, particularly in clearcuts where mud-stains on stumps are diagnostic. Yearlings sometimes hibernate away from the mother and 2 year olds and adult males commonly do. New burrows and lookout spots are a common feature of new or expanding colonies. Transplanted marmots quickly found and used abandoned burrows (Bryant et al., in press), and immigrant marmots will commonly use the same burrows and lookout spots as residents (Bryant, unpubl. data).

Home range

Heard (1977) documented home ranges of several hectares for individual adult marmots at one colony. Subsequent radio-telemetry generally corroborates these results but suggests that larger movements are occasionally made, particularly by yearlings and adult males. Marmots commonly shift their areas of use between early spring/late fall and summer periods. In natural colonies several habitat patches may be used. In clearcuts, marmots are often seen travelling along logging roads; daily movements of 500–1000 m are not uncommon (Bryant 1998, unpubl. data).

Movements and dispersal

A substantial fraction of subadult marmots disperse, apparently when 2 or 3 years old. Seven records of tagged and/or radio-telemetered subadults indicate movements greater than 10 km are common. One 2-year-old male moved 27 km within a month before being captured. Records of solitary marmots in low elevation habitats also suggest dispersal capability of 20–50 km (Bryant and Janz 1996).

Habitat

Structural stage

1: non-vegetated/sparse
2: herb
3a: low shrub

Important habitats and habitat features

Vancouver Island marmots require three essential habitat features: (1) grasses and forbs to eat, (2) colluvial soil structure for construction of overnight and overwintering burrows, and (3) microclimatic conditions that permit summer foraging, thermoregulation, and successful hibernation. Habitat scarcity is the fundamental reason for the rarity of *M. vancouverensis* (Bryant and Janz 1996).

Milko (1984) studied vegetation at three natural subalpine meadows and identified six major communities (*Phlox*-moss, *Anaphalis-Aster, Ribes-Heuchera, Pteridium aquilinum, Senecio-Veratrum* and *Vaccinium-Carex*). He concluded that such meadows are maintained by avalanches or snow-creep. Some natural meadows may be created by wildfires (Mount Whymper, Hooper North). Vancouver Island Marmots also inhabit clearcuts resulting from forestry, meadows created by ski-run development (Mount Washington and Green Mountain), and mine tailings (Mount Washington).

Bryant and Janz (1996) used average abundance (1972–1995) data to describe habitats used by marmots. They reported that most (81%) marmots were found between 1000 and 1400 m in elevation. Colonies in logged habitats were generally lower (median = 990 m; range = 730–1140 m) than natural subalpine meadows (median = 1240 m; range = 1040–1450 m). Most marmots were found on south- to west-facing slopes (74%). Most colonizations of clearcuts occurred within 10 years of logging (median = 8.5 years; range = 1–15 years) and within 1 km of natural colonies (median = 0.82 km; range = 0.4–4.5 km). Only a small fraction (<2%) of logged sites above 700 m elevation was eventually colonized by marmots. Maximum occupancy at logged sites is 21 years, but most (83%) animals inhabited clearcuts from 5–15 years after harvest (Bryant, unpubl. data). All marmot colonies in clearcuts are apparently now extinct.

Burrows

Vancouver Island marmots construct burrows in which to hibernate, bear young, hide from predators, and avoid environmental extremes. Burrows (including hibernacula) are commonly reused in multiple years by the same individuals (Bryant 1990; unpubl. data). One excavated burrow was >4 m in length with the sleeping chamber more than 1 m underground (Bryant et al., in press).

Escape burrows (used to avoid predators) may be a shallow excavation under a rock or tree root. Burrows used overnight or as birthing chambers are more elaborate, and often feature multiple entrances. As with escape burrows, they are typically constructed underneath a boulder or tree root system, which presumably offers supporting structure. Hibernacula are presumably deep enough that marmots can be underneath the frost layer. Work on alpine marmots (*M. marmota*) suggests that a critical feature of hibernacula may be its ability to maintain stable ambient temperatures close to 5°C (Arnold 1990; Arnold et al. 1991).

Burrow entrances are typically 30–45 cm in diameter and generally located on the downhill side of boulders or, in clearcut habitats, below stumps. Burrows used as hibernation or birth sites will almost always have some dirt mounded on the low side of the burrow entrance. Lounging spots are identifiable by mud stains on rocks or stumps.

Conservation and Management

Status

The Vancouver Island Marmot is on the provincial *Red List* in British Columbia. It is designated as *Endangered* in Canada (COSEWIC 2002).

Summary of ABI status in BC and adjacent jurisdictions (NatureServe Explorer 2002)

BC	Canada	Global
S1	N1	G1

Trends

Population trends

The Vancouver Island marmot is one of the rarest mammals in North America. The September 2001 population numbered fewer than 30 animals in the wild, distributed among five mountains. An additional 47 animals are in captivity.

Recent decades have seen a drastic reduction in occupied range and numbers (Bryant and Janz 1996). A short-term expansion occurred as marmots colonized clearcuts in the Nanaimo Lakes region during the 1980s. Populations expanded to a peak of 300–350 animals in 1984 and have declined drastically since then. Much of the decline was due to distinct "episodes" of high mortality at particular colonies (Bryant 2000). Per-capita birth rates have remained stable but death rates have increased. The spatial and temporal pattern of "crashes" is consistent with a hypothesis of predation and disease (Bryant 1998).

Black-tailed deer abundance declined dramatically from the mid-1970s through the late-1990s. Current populations are about 40% of the long-term average. Predation by cougar and wolf is largely responsible for the deer declines and circumstantial evidence suggests that predator-effort upon marmots has likely increased, especially in clearcut habitats.

Habitat trends

Milko (1984) suggested that vegetation changes have reduced habitat availability in recent decades (a view supported by Nagorsen et al. 1996). Under this interpretation, sites formerly occupied by marmots have changed in some qualitative way, and the species is confined to a shrinking geographic region in which suitable climatic and vegetation conditions are found. Several possible mechanisms have been suggested, including invasion of subalpine meadows by trees or *Pteridium* ferns, altered fire regime (Milko 1984), and changing food-plant availability (Martell and Milko 1986).

The evidence remains ambiguous. Invasion of subalpine meadows by trees has been documented for several areas in the Olympic (Fonda and Bliss 1969; Schreiner and Burger 1994) and Cascade mountains (Franklin et al. 1971). However, dendrochronological work at historic and extant colonies has produced surprising results (Laroque 1998; unpubl. data). In Strathcona Provincial Park, where marmots apparently disappeared some 10–30 years ago, most trees are more than 300 years of age, and there is little evidence of forest succession. Paradoxically, some of the highest-quality habitats within the present core area of distribution show considerable evidence of tree invasion within the past 50 years, probably as a result of post-fire regeneration (i.e., the Green-Gemini-Haley-Butler ridge system).

Previous speculation about the impact of dogs, ski-hill development, and all-terrain vehicles (Dearden and Hall 1983) has been discredited (Bryant 1998).

Forestry activities have changed the landscape dramatically in recent decades, particularly in the Nanaimo Lakes region (Bryant 1998). There was little forest harvesting prior to 1956 and much of what occurred was concentrated along valley bottoms. This pattern continued through the 1960s. Harvest rates increased during the 1970s, particularly at higher elevations. By 1976 over 75% of the annual harvest occurred above 700 m in elevation. At least 60% of all forests classified as mature were harvested in a 25-year period. Road development took place at a similar pace and increased five-fold in density. Potential clearcut marmot habitat was first created during the late 1960s and large amounts (>10 000 ha) became available during the 1970s.

Threats

Population threats

Ultimately the wild population is so small and fragmented that recovery is probably impossible without active human intervention in the form of captive breeding combined with reintroduction (Janz et al. 2000).

A major cause of mortality is predation. The number of potential predators is relatively small compared with other marmot species, with the only confirmed species being wolves (*Canis lupus*), cougars (*Puma concolor*), and golden eagles (*Aquila chrysaetos*). It is likely that bald eagles (*Haliaeetus leucocephalus*) and other diurnal raptors may occasionally take marmots, especially pups. Black bears are not known to prey upon marmots.

Habitat threats

Forestry activities continue adjacent to recently occupied marmot habitats, although the proportion of young clearcuts (potential marmot habitat) has declined significantly in recent years.

Death during hibernation has been confirmed only once although circumstantial evidence suggests this may occur often, especially in clearcuts. There is as yet no empirical evidence for a specific disease organism, although spatial and temporal patterns of mortality are consistent with a disease hypothesis (Bryant 2000).

Possible vegetation dynamics resulting from global warming remain impossible to predict. It may become necessary in the future to manipulate habitats to retain suitability for Vancouver Island Marmots.

Legal Protection and Habitat Conservation

Under the provincial *Wildlife Act*, the Vancouver Island Marmot is protected from killing, wounding, hunting and trapping, taking, and transporting including importing and exporting. It is listed as Endangered under the B.C. *Wildlife Act*.

The only currently occupied site on Crown land is partially protected within the Green Mountain Critical Wildlife Management Area (300 ha) and Haley Lake Ecological Reserve (120 ha).

Two currently occupied sites occur within private managed forest land. For a species at risk to be considered for special management under the Private Managed Forest Land regulations it must be designated as Identified Wildlife.

One currently occupied site occurs on private land.

Coarse filter provisions of the results based code are not sufficient to protect the habitats of this species.

Identified Wildlife Provisions

Wildlife habitat area

Goal

Maintain suitable habitat.

Feature

Establish WHAs at known colonies, reintroduction sites.

Size

Typically between 5 and 100 ha but will ultimately depend on the extent of the colony, or suitable habitat.

Design

The WHA should include a core area delineated by the outer perimeter of the colony and a 50–200 m management zone. The width of the management zone must be sufficient to maintain the microclimatic regime of the core area.

General wildlife measures

Goals

1. Protect burrows and denning animals.
2. Ensure integrity of burrow systems.
3. Maintain soil and drainage characteristics suitable for burrowing.

Measures

Access

- Do not construct roads or landings. Consult MWLAP when road maintenance, deactivation, or rehabilitation activities are required to ensure species requirements are adequately addressed.

Harvesting and silviculture

- Do not harvest or salvage in core area.
- Single tree or group selection systems may be determined to be appropriate in the management zone.
- Where timber harvesting with ground-based equipment is approved, it should only be conducted with low ground pressure equipment, to avoid damaging burrows.
- Do not use mechanical site preparation techniques that will damage burrows.

Pesticides

- Do not use pesticides.

Information Needs

1. Identification and mapping of suitable reintroduction sites.

Cross References

"Vancouver Island" White-tailed Ptarmigan

References Cited

Arnold, W. 1990. The evolution of marmot sociality: II. Costs and benefits of joint hibernation. Behav. Ecol. Sociobiol. 27:239–246.

Arnold, W., G. Heldmaier, S. Ortmann, H. Pohl, T. Ruf, and S. Steinlechner. 1991. Ambient temperatures in hibernacula and their energetic consequences for alpine marmots. J. Thermal Biol. 16:223–226.

Barash, D.P. 1989. Marmots: social behavior and ecology. Stanford Univ. Press, Stanford, Calif. 360 p.

Bryant, A.A. 1990. Genetic variability and minimum viable populations in the Vancouver Island marmot (*Marmota vancouverensis*). M.E.Des. thesis. Univ. Calgary, Calgary, Alta. 101 p.

_____. 1998. Metapopulation ecology of Vancouver Island Marmots (*Marmota vancouverensis*). Ph.D. dissertation. Univ. Victoria, Victoria, B.C. 125 p.

_____. 2000. Relative importance of episodic versus chronic mortality in the decline of Vancouver Island Marmots (*Marmota vancouverensis*). *In* Proc. Conf. on the biology and management of species and habitats at risk. L.M. Darling (editor). Kamloops, B.C., Feb. 15–19, 1999. B.C. Min. Environ., Lands and Parks, Victoria, B.C., and Univ. Coll. Cariboo, Kamloops, B.C., pp. 189–196.

Bryant, A.A. and D.W. Janz. 1996. Distribution and abundance of Vancouver Island Marmots (*Marmota vancouverensis*). Can. J. Zool. 74:667–677.

Bryant, A.A., H.M. Schwantje, and N.I. deWith. 2002. Disease and unsuccessful reintroduction of Vancouver Island marmots (*Marmota vancouverensis*). *In* Holarctic marmots as a factor of biodiversity. K.B. Armitage and V.U. Rumianster (editors). ABF Publishing House, Moscow. pp. 101–107.

Committee on the Status of Endangered Wildlife in Canada (COSEWIC). 2002. Canadian Species at Risk. www.speciesatrisk.gc.ca

Dearden, P. and C. Hall. 1983. Non-consumptive recreation pressures and the case of the Vancouver Island marmot (*Marmota vancouverensis*). Environ. Conserv. 10:63–66.

Fonda, R.W. and L.C. Bliss. 1969. Forest and vegetation of the montane and subalpine zones, Olympic Mountains. Ecol. Monogr. 39:271–301.

Franklin, J.F., W.H. Moir, G.W. Douglas, and C. Wiberg. 1971. Invasion of subalpine meadows by trees in the Cascade Range, Washington and Oregon. Arct. Alpine Res. 3:215–224.

Heard, D.C. 1977. The behaviour of Vancouver Island marmots (*Marmota vancouverensis*). M.Sc. thesis. Univ. B.C., Vancouver, B.C. 129 p.

Hoffmann, R.S., J.W. Koeppl, and C.F. Nadler. 1979. The relationships of the amphiberingian marmots (Mammalia: Sciuridae). Mus. Nat. Hist., Univ. Kansas, Lawrence, Kans. Occas. Pap. 83:1–56.

Janz, D.W., A.A. Bryant, N.K. Dawe, H. Schwantje, B. Harper, D. Nagorsen, D. Doyle, M. deLaronde, D. Fraser, D. Lindsay, S. Leigh-Spencer, R. McLaughlin, and R. Simmons. 2000. National Recovery Plan for the Vancouver Island Marmot: 2000 Update.

RENEW (Recovery of Nationally Endangered Wildlife), Ottawa, Ont.

Kruckenhauser, L., W. Pinsker, E. Haring, and W. Arnold. 1999. Marmot phylogeny revisited: molecular evidence for a diphyletic origin of sociality. J. Zool. Syst. Evol. Res. 37:49–56.

Laroque, C.P. 1998. Tree invasion in subalpine Vancouver Island marmot meadows. Report to the B.C. Environmental Research Scholarship Committee, Victoria, B.C. Unpubl. 36 p.

Martell, A.M. and R.J. Milko. 1986. Seasonal diets of Vancouver Island marmots. Can. Field-Nat. 100:241–245.

Milko, R.J. 1984. Vegetation and foraging ecology of the Vancouver Island marmot (*Marmota vancouverensis*). M.Sc. thesis. Univ. Victoria, Victoria, B.C. 127 p.

Nagorsen, D.W. 1987. *Marmota vancouverensis*. Mamm. Species 270:1–5.

Nagorsen, D.W., G. Keddie, and T. Luszcz. 1996. Vancouver Island marmot bones from subalpine caves: archaeological and biological significance. B.C. Min. Environ., Lands and Parks, Victoria, B.C. Occas. Pap. No. 4. 58 p.

NatureServe Explorer. 2002. An online encyclopaedia of life. Version 1.6. NatureServe. Arlington, VA. Available at http://www.natureserve.org/explorer/

Rausch, R.L. and V.R. Rausch. 1971. The somatic chromosomes of some North American marmots. Extrait de Mammalia 35:85–101.

Schreiner, E.G. and J.E. Burger. 1994. Photographic comparisons: a qualitative appraisal of the influence of climate and disturbances on vegetation, 1915–1990. *In* Mountain Goats in Olympic National Park: biology and management of an introduced species. D.B. Houston, E.G. Schreiner, and B.B. Moorhead (editors). U.S. Dep. Inter. Sci. Monogr. NPS/NROLYM/NRSM-94/25, pp. 139–172.

Steppan, S.J., M.R. Akhverdyan, E.A. Lyapunova, D.G. Fraser, N.N. Vorontsov, R.S. Hoffmann, and M.J. Braun. 1999. Molecular phylogeny of the marmots (Rodentia: Sciuridae): tests of evolutionary and biogeographic hypotheses. Syst. Biol. 48:715–734

Swarth, H.S. 1911. Two new species of marmots from Northwestern America. Univ. Calif. Publ. Zool. 7:201–204.

_____. 1912. Report on a collection of birds and mammals from Vancouver Island. Univ. Calif. Publ. Zool. 10:1–124.

Wilson, D.E. and D.M. Reeder. 1993. Mammal species of the world: a taxonomic and geographic reference. Smithsonian Inst. Press, Washington, D.C.

WOLVERINE

Gulo gulo

Original[1] prepared by R.D. Weir

Species Information

Taxonomy

Wolverines (*Gulo gulo*) are members of the family Mustelidae (subfamily Mustelinae) in order Carnivora. Wolverines are currently considered one species throughout their circumpolar range (Kurten and Rausch 1959), although two subspecies are recognized: *G. gulo luscus* (North America), and *G. gulo gulo* (Eurasia). Banci (1982) determined that there were insufficient differences in cranial morphology to consider the Vancouver Island wolverine as a subspecies distinct from mainland wolverines in British Columbia. Although they are the sole members of their genus, wolverines are most closely related to members of the genus *Martes* (e.g., American Marten, Fisher; Dragoo and Honeycutt 1997).

Description

Wolverines are the largest terrestrial members of the weasel family. Wolverines are sexually dimorphic, with the body mass of males ranging from 12 to 18 kg and females ranging from 8 to 12 kg (Hash 1987). Wolverines have stout bodies ranging from 65 to 105 cm in length with moderately bushy tails 17–26 cm in length (Hash 1987). Wolverines are most easily identified by their pelage that is dark chocolate brown over most of the body with lighter-coloured hair around the forehead and along a lateral stripe extending from the ears or shoulder to the sacral region.

Distribution

Global

Wolverines are holarctic in their distribution, generally occurring between 45° and 70° latitude in North America and 50° and 70° latitude in Eurasia (Wilson 1982). Wolverines occur in the tundra, taiga plains, and boreal forests of North America, Europe, and Russia, and in many of the montane habitats of the western Cordillera of North America.

British Columbia

Wolverines are widely distributed, albeit at low densities, throughout much of British Columbia. Wolverine populations do not occur on the Queen Charlotte Islands and may be extirpated from Vancouver Island, the lower Fraser Valley, the Okanagan Basin, and the Thompson Basin.

Forest region and districts

Wolverines likely occur in portions of each forest region, except for the Queen Charlotte Islands, South Island forest districts, and possibly other districts on Vancouver Island (e.g., North Island and Campbell River).

Ecoprovinces and ecosections

Wolverines occur in all terrestrial ecoprovinces, except for the Georgia Depression Ecoprovince.

Biogeoclimatic units

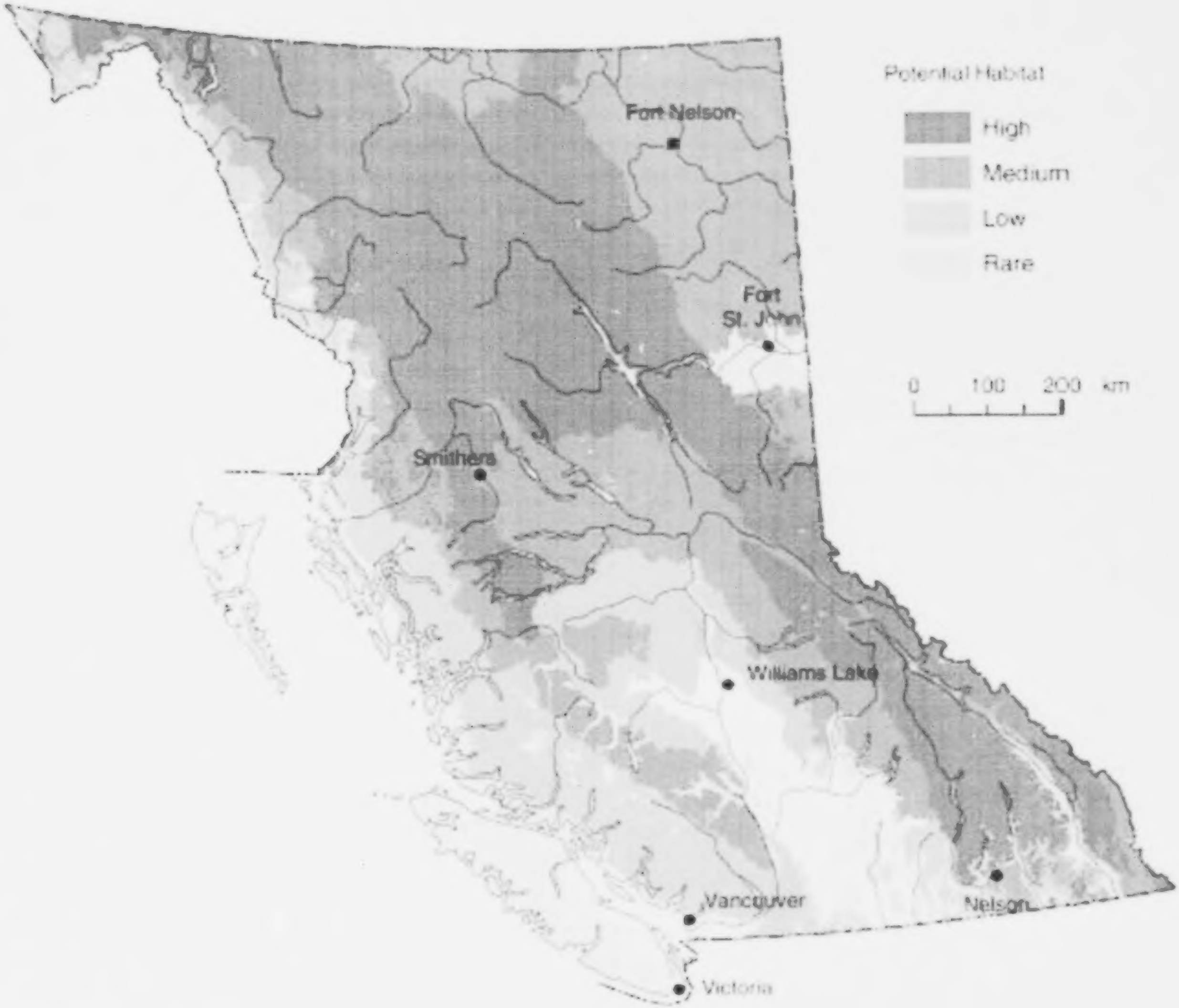
Wolverines can occur in all biogeoclimatic zones, except for BGxh, BGxw, CDFmm, CWHwh, IDFxh, IDFxm, IDFxw (and all grassland phases in the IDF), PPdh, and PPxh subzones.

---

[1] Draft account for Volume 1 prepared by E. Lofroth.

Wolverine

(Gulo gulo)


Potential Habitat
High
Medium
Low
Rare
0 100 200 km
Fort Nelson
Fort St. John
Smithers
Williams Lake
Vancouver
Nelson
Victoria

Note: This map represents a broad view of the distribution of potential habitat used by this species. The map is based on several ecosystem classifications (Ecoregion, Biogeoclimatic and Broad Ecosystem Inventory) as well as current knowledge of the species' habitat preferences. This species may or may not occur in all areas indicated.

Biogeoclimatic zones and subzones with the capability to support wolverines

AT: p

BWBS: dk, mw, unr, vk, wk

CWH: dm, ds, mm, ms, unc, vh, vm, wm, ws, xm

ESSF: dc, dcp, dk, dkp, dv, dvp, mc, mk, mm, mv, mw,,mwp, ung, vc, vcp, wc, wcp, wk, wm, wv, xc, xcp, xv

ICH: dk, dw, mc, mk, mm, mw, vc, vk, wc, wk, xw

IDF: dk, dm, dw, mw, unk, unn, unv, ww

MH: mm, unr, wh

MS: dc, dk, dm, dv, unk, unv, xk, xv

PP: dh

SBPS: dc, mc, mk, xc

SBS: dh, dk, dw, mc, mh, mk, mm, mw, unk, unr, vk, wk

SWB: dk, mk, unr, vk

Note that wolverines may not currently occur in each of the subzones listed.

Broad ecosystem units

Wolverines likely use a wide variety of broad ecosystem units (BEUs). The following BEUs may be used by wolverines; however, the intensity and frequency of use is likely highly variable and linked to the ability of the habitat to support specific food sources (e.g., moose, caribou, hoary marmots). Each unit has been assigned a rank to denote its relative importance to wolverine ecology (1 = high, 2 = medium, 3 = low, 4 = very low) (Lofroth 2001, J.A. Krebs, pers. comm.). There is very limited data for the coastal habitats.

Unit	Likely Importance	Unit	Likely Importance
AD	4	LP	2?
AG	1	ME	4
AH	1	MF	3
AM	1	MR	4
AN	3	MS	3
AS	2	PB	4
AT	1	PR	1
AV	1	RB	3
BA	2	RD	3
BB	4	RR	1
BG	4	RS	3
BK	2	SA	2
BL	3	SB	3
BP	3	SC	3
CG	3	SD	3
CH	3	SF	2
CP	4	SG	2
CR	1	SH	3
CS	2	SK	2
CW	3	SL	3
DF	4	SM	1
DL	4	SR	2
EF	2?	SU	2
ER	1	SW	2
ES	3	TA	1
EW	2?	TB	2?
FB	3	TF	4?
FE	4	WB	2
FP	1	WG	4
FR	3	WL	3
HB	3	WM	3
HL	4	WP	2
HP	2	WR	1
HS	3	YB	4
IG	2	YM	3
IH	2	YS	4?
IS	2?		

Elevation

Wolverines range from valley bottoms to alpine meadows. The upper limit of their elevational range is likely limited by the distribution of prey at higher altitudes (J.A. Krebs, pers. comm.). In areas with mountainous terrain, there appears to be some segregation in use of different elevations among sex and age classes (Whitman et al. 1986, Lofroth 2001); adult females typically occur at higher elevations than other sex and age classes, followed by subadult females, then adult males (Lofroth 2001). Subadult males typically occur at the lowest elevations.

Life History

Diet and foraging behaviour

Wolverines consume a variety of food items, but large ungulates (e.g., moose [*Alces alces*], elk [*Cervus elaphus*], caribou [*Rangifer tarandus*], deer [*Odocoileus* spp.], and mountain goats [*Oreamnos americanus*]), primarily obtained as carrion, form a large component of their diet (Hash 1987). Wolverines are also reported to eat snowshoe hares (*Lepus americanus*), porcupines (*Erethizon dorsatum*), sciurids (including marmots), mice and voles, birds, fish, and vegetation (Banci 1994).

Composition of the diet appears to vary seasonally and with the sex of the individual. In the Omineca region, moose are consumed throughout the year by all age and sex classes (Lofroth 2001). However, during summer, adult females with kits included hoary marmots (*Marmota caligata*) as a substantial portion of their diet. Banci (1987) speculated that small mammals become more important as a prey item as the availability of large ungulate carrion diminishes.

The reliance upon particular species for food likely varies regionally with availability of the species. In the Omineca region, wolverines consume moose throughout the year (Lofroth 2001). In the north Columbia Mountains, wolverines consume caribou, mountain goats, and moose most frequently (J.A. Krebs, pers. comm.). In areas with anadromous salmon runs, fish may be an important supply of food for wolverines (Banci 1987).

Female wolverines are faced with an energy bottleneck while using natal and maternal dens. Their dens appear to have specific structural requirements (see "Habitat," below), but they must also be relatively close to a reliable source of food. In both the Omineca region and northern Columbia Mountains, female wolverines situate their natal and maternal dens in areas bordering the ESSF/ESSFp ecotone in early April. The timing of this process concurs with the movement of caribou to high-elevation areas in late winter. The prevalence of caribou remains in scats collected at natal dens suggests that female wolverines rely heavily upon caribou as a predictable food source during this period (Lofroth 2001). Krebs and Lewis (2000) speculated that kit production and survival might be strongly linked to carrion supply.

Researchers have long assumed that wolverines primarily scavenge for food. Wolverines are well-known for their ability to detect animal remains buried under several feet of snow and are also reported to cache food that they have scavenged and revisit these sites later in the year (Hash 1987). It is speculated that wolverines obtain about 60% of their food intake through carrion (E. Lofroth, pers. comm.). However, in the Omineca region and Columbia Mountains, researchers have observed wolverines attacking and killing caribou (Lofroth 2001). In the rugged and snowy northern Columbia Mountains, wolverines appear to rely heavily upon avalanche-killed ungulates (e.g., caribou, mountain goats, moose) during winter and may be less reliant on wolf predation as a source of carrion than in other areas (J.A. Krebs, pers. comm.). Wolverines appear to actively hunt smaller prey during non-winter periods and rely less upon carrion (E. Lofroth, J.A. Krebs, pers. comm.).

Wolverines search widely for food. Daily movements for wolverines can be up to 65 km (Wilson 1982). Female wolverines regularly move 20 km a day even while maintaining a natal den (E. Lofroth, pers. comm.). It is unknown if they use any specific habitats preferentially for foraging, although the activity rates of wolverines within late successional and riparian forest indicate that this may be a heavily used habitat while foraging or searching for prey or carrion (Lofroth 2001).

Reproduction

Wolverines breed between late April and early September but embryos do not implant until January. Sometime between late February and mid-April, females give birth to between one and five cubs. They nurse for 8–9 weeks after which they leave the den but stay with mother for their first winter learning to hunt. Young disperse in spring. Natal dens are often underground.

Site fidelity

Wolverines are not widely reported to exhibit strong site fidelity, except for females with natal or maternal dens. While rearing kits, females will use a natal den for approximately 20–60 days and between one and four maternal dens for 5–20 days each (Magoun and Copeland 1998; Lofroth 2001). These dens are not likely reused between years.

Home range

Only adult wolverines maintain distinct home ranges. Wolverines have mildly intrasexually exclusive home ranges, where males will overlap with one or more females and other males, but females will not overlap their home ranges with other females (Krebs and Lewis 2000). Male home ranges are typically three times the size of those of females (Omineca, males: 1366 km², females: 405 km² [Lofroth 2001]; northern Columbia Mountains, males: 1005 km², females: 311 km² [Krebs and Lewis 2000]). Home ranges are maintained between years.

Movements and dispersal

Daily movements of wolverines are likely mediated most strongly by the availability and distribution of food throughout the year, although wolverines do spend substantial time moving through mature and old forest structural stages (E. Lofroth, pers. comm.). Wolverines in the northern Columbia Mountains seem to prefer moving about the landscape by following watercourses and using low elevation passes between valleys (J.A. Krebs, pers. comm.).

However, human-caused features can have a substantial effect on the ability of wolverines to move successfully throughout the landscape. Human activity (e.g., log hauling, logging, mining) may displace or alter movement paths of wolverines in highly modified landscapes (Lofroth 2001) and wolverines will often avoid entering young (<25 years) cutblocks while travelling (J.A. Krebs, pers. comm.). Transportation corridors can interrupt or alter daily movements (Austin et al. 2000) and can be a source of mortality within the population (Krebs and Lewis 2000). Man-made reservoirs may alter the dispersal routes of wolverines in the landscape (E. Lofroth, J.A. Krebs, pers. comm.). Kyle and Strobeck (2001) speculated that habitat loss, overharvest, major transportation corridors, and other anthropogenic factors limit successful dispersal among metapopulations. The viability of populations of wolverines in southern portions of the range may depend upon large areas of undisturbed habitat with corridors connecting them.

Subadult female wolverines typically disperse short distances away from their natal home ranges and males disperse 30–100 km (Magoun 1985), although dispersals of up to 378 km have been documented (Gardner et al. 1986). Subadult wolverines are slightly nomadic and travel widely prior to establishment of a permanent home range. Movements by subadults are characterized by periods of concentrated use of a relatively small area, interspersed by large-scale movements (Lofroth 2001). Subadults typically establish a home range by the time they reach 24 months. Habitat composition likely plays a relatively small role in dispersal; however, extensively clearcut watersheds would likely be avoided while transient (J.A. Krebs, pers. comm.).

Habitat

Structural stage

Wolverines, being dependent upon a variety of different food items throughout the year, use a wide assortment of structural stages in their day-to-day life, although mature and old forest structural stages are used predominately. In the Omineca region of north-central British Columbia, Lofroth (2001) reported that at least 50% of the locations of radio-tagged wolverines were in late successional stands (structural stages 6 and 7) and wolverines had relatively little use of mid-successional stands (stages 3 and 4). He also noted that the use of structural stages by wolverines varied among sexes and seasons; females tended to use both early-successional (stages 1 and 2) and late-successional stands (stages 6 and 7), while males used mostly late-successional stands. Most of the use of early-successional stands by females occurs in the use of high elevation habitats during the rearing season, when they are provisioning for young. In the northern Columbia

Mountains, wolverines tend to use late-successional stands (stages 6 and 7) most frequently when they are not using alpine habitats. Wolverines in this area may use late-successional forests because they confer some thermal and security cover benefits (J.A. Krebs, pers. comm.). To date, neither of these studies has completed their respective habitat selectivity analyses, so these results are preliminary estimates of use, not selectivity.

At a landscape spatial scale, wolverines tend to have some broad patterns of use. In mountainous areas of British Columbia, females tend to use ESSF biogeoclimatic zones during winter and AT zones during the summer. Males, on the other hand, tend to use lower elevation zones during winter and switch to ESSF zones during the summer (Krebs and Lewis 2000, Lofroth 2001). Wolverine populations tend to occur in areas where a diversity of abundant seasonal food is available within home ranges, which is often related to elevational diversity.

Important habitats and habitat features

"Habitat" for wolverines is not easily delineated as a set of vegetative parameters, such as those that are typically used to identify and classify terrestrial ecosystems, but is likely defined by the distribution and abundance of food, including carrion as well as suitable habitat/structures for denning and rendezvous points (i.e., sheltered places where kits are left during foraging periods). Most studies of wolverine habitat use show little, if any, selection for habitat at the stand scale (e.g., Whitman et al. 1986; Banci and Harestad 1990). This is likely because wolverines are not small-scale habitat specialists but rather require a suite of habitat variables that occur at larger spatial scales (e.g., landscapes, regions).

Thus, wolverines do not have easily defined habitats or small-scale habitat features for which they select. For lactating females and their young, an arrangement of habitats that provide a suitable supply of large ungulate carrion during the late winter in close juxtaposition to an area that supplies adequate food during summer (e.g., marmots) and suitable shelter is important (Krebs and Lewis 2000).

Natal and maternal dens are probably the only small-scale structures for which wolverines exhibit selection. Female wolverines typically situate dens in snow tunnels leading to masses of fallen trees (accumulations of classes 1–3 coarse woody debris [CWD]) or rocky colluvium (Magoun and Copeland 1998; Krebs and Lewis 2000; Lofroth 2001). The CWD associated with natal and maternal dens is likely formed through a variety of processes, such as windfall, avalanches, and insect-induced mortality. Natal and maternal dens are generally associated with small-scale forest openings (e.g., <100 m across) at high-elevations (i.e., ESSF/ESSFp ecotone; Krebs and Lewis 2000; Lofroth 2001). The composition and placement of dens within the landscape is important because these structures provide security for kits (i.e., snow cover) with proximity to food resources (i.e., late-winter carrion or prey).

Conservation and Management

Status

The Vancouver Island Wolverine is on the provincial *Red List* in British Columbia; whereas the mainland subspecies is on the provincial *Blue List*. The eastern Canadian population in the Ungava Peninsula and Labrador is designated *Endangered* (COSEWIC 2002). The western Canadian (YT, NT, NU, BC, AB, SK, MB, ON) population of wolverines is considered to be of *Special Concern* (COSEWIC 2002). Wolverine populations in Eurasia are believed to be at a low density, but stable (Hash 1987).

Summary of ABI status in BC and adjacent jurisdictions (NatureServe Explorer 2002)

Population	BC	ID	MT	Canada	Global
Vancouver Island	S1	–	–	N1	G4T1Q
Mainland BC	S3	S2	S2	N4	G4T4

Trends

Population trends

Very little is known about the size of the population of wolverines in British Columbia and no current estimate of the population size exists for the province. However, a specific density estimate was produced for 1996 and 1997 in the northern Columbia Mountains, where researchers estimated the density of wolverines at approximately 25 wolverines in the 4000 km² study area, or 1 wolverine/160 km² (Krebs and Lewis 2000). This estimate is not substantially different than the estimate produced for the south-western Yukon of 1 wolverine/177 km² (Banci and Harestad 1990). It is not known how applicable these estimates are to other areas in the province.

The relative ability of a population to remain stable or increase is largely dependent upon the survivorship of individuals within it. In a review of population vital rates of wolverines in western North America from 11 research studies, Krebs et al. (2000) determined that survivorship rates of wolverines varied depending upon whether the population was from tundra, boreal, or temperate regions and if the population was exposed to trapping. The highest survivorship rates were among the tundra-untrapped populations, while the lowest were among the temperate-trapped populations. They also concluded that human-caused mortality (e.g., trapping) is additive, not compensatory. Using this as a framework, wolverine populations are probably healthiest in the northern, inaccessible mountain regions of the province. Populations in the southern half of the province that are exposed to human development and trapping pressure likely have poorer survivorship and are thus more tenuous. Kyle and Strobeck (2001) speculated that the high degree of genetic isolation among the wolverines in the northern Columbia Mountains was due to a lack of connectivity between subpopulations and indicated an isolated population that may be more susceptible to stochastic events.

Habitat trends

The suitability of habitat in much of the range of the wolverine has declined over the past 30 years. Conversion of large, contiguous tracts of mature and old forests have likely affected the diversity and abundance of prey and carrion available to wolverines and likely affected the permeability of the landscape for dispersal. Development of previously inaccessible watersheds has introduced trapping mortality and transport-related (i.e., roads, rail) mortality into previously unharvested populations. Logging of high elevation forests may also influence the availability or success of natal and maternal dens.

Threats

Population threats

As noted by Banci and Proulx (1999), wolverine populations have low resiliency to population perturbation (e.g., fur trapping) because of their low densities, large home range sizes, and relatively low reproductive rate. Wolverine populations are believed to sustain a harvest rate of 6% of the population per year (Krebs et al. 2000). Recent analysis of wolverine survivorship has suggested that trapping mortality is additive, not compensatory (Krebs et al. 2000). Historic overharvest of wolverines has certainly contributed to their North American decline. A changing prey base, mediated by habitat and population manipulations by humans, may have also been a source of population decrease over the past 100 years. The primary population threat is the additive mortality resulting from fur harvesting. The increased access provided by forest development greatly enhances the ability of trappers to harvest wolverines in previously inaccessible areas.

Wolverines may also be very sensitive to disturbance particularly disturbance from roads and recreational activities (e.g., heli-skiing, snowmobiling).

Habitat threats

As stated by Banci (1994), the cumulative impacts of trapping, habitat alterations, forest harvesting, and forest access on wolverine populations are not well understood. Although wolverines are not widely reported to be a habitat specialist, habitat loss and alienation are commonly thought to be a major contributing factor to population declines (Banci 1994). The major habitat threat is the large-scale conversion of mature and old forest structural stages into early structural stage habitats. Logging of high elevation forests may also affect rearing success.

Legal Protection and Habitat Conservation

Under the provincial *Wildlife Act*, wolverines are protected from killing, wounding, and taking, and legal harvest for their pelts is regulated. Intentional harvest of wolverines is not permitted in regions 1, 2, and 8. Open trapping seasons on wolverines occur in regions 3, 4, 5, 6, and 7. There is no quota for harvests of wolverines in these regions but trappers must report the capture of wolverines within 15 days following the end of the trapping season. As recorded in the Fur Harvest Database, an average of 168 wolverines were harvested annually over the past decade (Lofroth 2001). Unreported harvests and discrepancies in the harvest reporting system suggest that the actual harvest of wolverines in British Columbia may be different (I. Adams, pers. comm.). Wolverines are also considered "small game" and may be hunted in regions 4, 6, and 7. The annual bag limit for these regions is one wolverine.

Areas protected from timber harvest and trapping are likely an important component of conservation of wolverines in British Columbia (Hatler 1989). Because of large space requirements, low density, and low resiliency to trapping, these refugia are likely critical to the persistence of wolverines in many landscape units. Several parks likely include suitable habitat for wolverines (e.g., Glacier National Park); however, wolverines have very large home ranges and most parks in British Columbia are not large enough to encompass the home range of a wolverine.

Several provisions of the results based code should maintain small-scale habitats for wolverines including recommendations for landscape unit planning and riparian management. Wildlife habitat features may also be used to manage den sites. However, because wolverines occur at low densities and cover large areas, maintaining wolverine habitat will also need to be implemented through higher level plans.

Identified Wildlife Provisions

Effective management of wolverine habitat needs to occur at the landscape spatial scale. Maintaining refugia (i.e., areas with limited resource and recreational activities and trapping), seasonal foraging areas, secure denning sites, adequate movement corridors, and limiting mortality within populations need to be implemented for successful conservation of the species. These issues can best be addressed by incorporating the connectivity of habitats, creation of refugia, and the arrangement and timing of forest development in strategic level plans.

Sustainable resource management and planning recommendations

- Refugia are probably the single most important landscape planning mechanism for the conservation of wolverine populations in British Columbia. Refugia should be designed using suitable portions of watersheds in juxtaposition with protected areas and no trapping areas that are determined in consulation with the Fish, Wildlife and Allocation Branch of the Ministry of Water, Land and Air Protection, and as part of a recovery planning process.
- Plan forest development to occur on one side of a watershed at a time where practicable. Limiting concurrent development will concentrate the activity at any one time and allow wolverines to avoid operational areas as much as possible during their daily movements. This will reduce the mortality risk (e.g., road kill, trapping) and displacement associated with forest development and will help facilitate normal movement throughout the landscape.
- Minimize road access (i.e., number of km and length of time active). The increase in access associated with forest development into previously pristine areas (especially large drainages) exposes resident wolverines to a much higher mortality risk from hunting, poaching, and road traffic. Careful road planning and deactivation should be considered.

- Maintain seasonal foraging areas. Seasonal foraging areas can be maintained through the appropriate juxtaposition of structural stages throughout a watershed. Adequate foraging habitat for wolverines is likely closely linked to the suitability of habitats to support their primary food sources (ungulates, snowshoe hares, porcupines, marmots). Maintaining these habitats near adequate thermal and security cover (generally mature and old forest structural stages) will be important to securing seasonal foraging areas for wolverines. In mountainous regions, this will entail planning for seasonal prey across several biogeoclimatic zones (e.g., ICH, ESSF, AT).
- Maintain suitable denning sites. Suitable sites are secure and undisturbed, and have the appropriate structure (see "Important habitats and habitat features" above). These need to be close to reliable food sources (carrion from late winter avalanches, prey) and are likely best supplied in the ecotone of the ESSF/ESSFp/ATp.
- Minimize disturbance at suitable denning sites. Logging should not occur near identified avalanche chutes or late-winter areas for caribou. Forestry operations should not occur in these areas between March and June when females are more sensitive to human disturbance. In areas without a diversity of elevations (and resulting BEC zones), additional factors will need to be taken into consideration to ensure the provision of secure den sites for wolverines. In relatively flat areas, such as the Fraser Plateau, denning wolverines may be more vulnerable to the effects of habitat alterations because their dens are more likely to occur in harvestable areas.
- Retain suitable movement and dispersal corridors. Habitat connectivity within and between watersheds is very important for successful daily movements, foraging, and dispersal of wolverines. Connectivity of valley bottom habitats is important, specifically along watercourses. These corridors should be dominated by older forests (stage 6 or 7) and it is important to connect, not only the valley bottom habitats, but also provide movement corridors between the valley bottom and patches of ESSF/AT habitats. Large connectivity corridors should be maintained between refugia where human disturbance is prevalent. These should also be dominated by older forests (stages 5–7).

Additional Management Considertaions

Minimize disturbance from recreational activities (e.g., heli-skiing, snowmobiling) near maternal dens.

Information Needs

1. Ecology in non-mountainous landscapes.
2. Dispersal through fragmented landscapes.
3. Reproductive rates.

Cross References

Fisher, Caribou

References Cited

Austin, M.A., S. Herrero, and P. Paquet. 2000. Wolverine winter travel routes and response to transportation corridors in Kicking Horse Pass between Yoho and Banff National Parks. *In* Proc. Conf. on the biology and management of species and habitats at risk. L.M. Darling (editor). Kamloops, B.C., Feb. 15–19, 1999. B.C. Min. Environ., Lands and Parks, Victoria, B.C., and Univ. Coll. Cariboo, Kamloops, B.C., p. 705.

Banci, V. 1982. The wolverine in British Columbia: distribution, methods of determining age and status of *Gulo gulo vancouverensis*. B.C. Min. For. and B.C. Min. Environ., Victoria, B.C. Integrated Wildl. Intensive For. Res. Rep. IWIFR-15.

_____. 1987. Ecology and behaviour of wolverine in Yukon. Thesis. Simon Fraser Univ., Burnaby, B.C.

_____. 1994. Wolverine. *In* The scientific basis for conserving forest carnivores: American marten, fisher, lynx, and wolverine in the western United States. L.F. Ruggiero, K.B. Aubry, S.W. Buskirk, L.J. Lyon, and W.J. Zielinski (technical editors). U.S. Dep. Agric. For. Serv., Rocky Mtn. For. Range Exp. Stn., Fort Collins, Colo., pp. 99–127.

Banci, V. and A.S. Harestad. 1990. Home range and habitat use of wolverines *Gulo gulo* in Yukon, Canada. Holarctic Ecol. 13:195–200.

Banci, V. and G. Proulx. 1999. Resiliency of furbearers to trapping in Canada. *In* Mammal trapping. G. Proulx (editor). Alpha Wildlife Research & Management, Sherwood Park, Alta., pp. 175–204.

Committee on the Status of Endangered Wildlife in Canada (COSEWIC). 2002. Canadian Species at Risk. www.speciesatrisk.gc.ca

Dragoo, J.W. and R.L. Honeycutt. 1997. Systematics of mustelid-like carnivores. J. Mammal. 78:426–443.

Gardner, G.L., W.B. Ballard, and R.H. Jessup. 1986. Long distance movement by an adult wolverine. J. Mammal. 67:603.

Hash, H.S. 1987. Wolverine. *In* Wild furbearer management and conservation in North America. M. Novak, J.A. Baker, M.E. Obbard, and B. Malloch (editors). Ont. Trappers Assoc., North Bay, Ont., pp. 574–585.

Hatler, D.F. 1989. A wolverine management strategy for British Columbia. B.C. Min. Environ., Wildl. Br., Victoria, B.C. Wildl. Bull. B-60.

Krebs, J.A. and D. Lewis. 2000. Wolverine ecology and habitat use in the North Columbia Mountains: progress report. *In* Proc. Conf. on the biology and management of species and habitats at risk. L.M. Darling (editor). Kamloops, B.C., Feb. 15–19, 1999. B.C. Min. Environ., Lands and Parks, Victoria, B.C., and Univ. Coll. Cariboo, Kamloops, B.C., pp. 695–703.

Krebs, J.A., E.C. Lofroth, J. Copeland, H. Golden, M. Hornocker, D. Cooley, V. Banci, A. Magoun, R. Mulders, and B. Shults. 2000. Rates and causes of mortality in North American wolverines. Presentation at Carnivores 2000, Denver, Colo.

Kurten, B. and R.L. Rausch. 1959. Biometric comparisons between North American and European mammals. I. A comparison between Alaskan and Fennoscandian wolverine (*Gulo gulo* Linnaeus). Acta Arctica 11:1–20.

Kyle, C.J. and C. Strobeck. 2001. Genetic structure of North American wolverine (*Gulo gulo*) populations. Mol. Ecol. 10:337–347.

Lofroth, E.C. 2001. Wolverine ecology in plateau and foothill landscapes 1996–2001. Northern wolverine project: 2000/01 year-end report. Report for B.C. Min. Environ., Lands and Parks, Wildl. Br., Victoria, B.C. Unpubl.

Magoun, A. and J.P. Copeland. 1998. Characteristics of wolverine reproductive den sites. J. Wildl. Manage. 62:1313–1320.

Magoun, A.J. 1985. Population characteristics, ecology, and management of wolverines in northwestern Alaska. Dissertation. Univ. Alaska, Fairbanks, Alaska.

NatureServe Explorer. 2002. An online encyclopaedia of life. Version 1.6. NatureServe. Arlington, VA. Available at http://www.natureserve.org/explorer/

Whitman, J.S., W.B. Ballard, and C.L. Gardner. 1986. Home range and habitat use by wolverines in southcentral Alaska. J. Wildl. Manage. 50:460–463.

Wilson, D.E. 1982. Wolverine. *In* Wild mammals of North America, biology, management, and economics. J.A. Chapman and G.S. Felhamer (editors). Johns Hopkins Univ. Press, Baltimore, Md., pp. 644–652.

Personal Communications

Adams, I. 2001. Min. Environ., Lands and Parks, Victoria, B.C.

Krebs, J.A. 2001. Columbia Basin Fish and Wildlife Compensation Program.

Lofroth, E.C. 2001. Min. Water, Land and Air Protection, Victoria, B.C.

Acronyms

asl	above sea level
ATV	all terrain vehicle
BEC	biogeoclimatic ecosystem classification
BEU	broad ecosystem unit
CCLUP	Cariboo-Chilcotin Land Use Plan
CDC	Conservation Data Centre
COSEWIC	Committee on the Status of Endangered Wildlife in Canada
CWD	coarse woody debris
dbh	diameter at breast height
FPC	Forest Practices Code
FRPA	*Forest and Range Practices Act*
GBMA	Grizzly Bear Management Area
GBPU	Grizzly Bear Population Unit
GWM	general wildlife measure
HLP	higher level plan
IWMS	Identified Wildlife Management Strategy
LTAC	Long-term Activity Centre
LWD	large woody debris
MOF	Ministry of Forests
MSRM	Ministry of Sustainable Resource Management
MWLAP	Ministry of Water, Land and Air Protection
NDT	natural disturbance type
OGMA	old growth management area
PFA	post-fledging area
RBC	results based code
RISC	Resource Information Standards Committee
RMA	riparian management area
RMZ	resource management zone
SD	standard deviation
SDM	statutory decision maker
s.e.	standard error
slv	snout-to-vent length
sp.	species (singular)
spp.	species (plural)
ssp.	subspecies
TAC	IWMS Technical Advisory Committee
TEM	Terrestrial ecosystem mapping
UWR	ungulate winter range
WAP	watershed assessment procedure
WHA	wildlife habitat area
WTP	wildlife tree patch

Glossary

For more definitions, refer to Glossary of Forest Terms web page (http://www.for.gov.bc.ca/hfd/library/documents/glossary/index.htm).

account: Specific information on taxonomy, distribution, life history, status, and management recommendations for Identified Wildlife.

age class: Any interval into which the age ranges of trees, forests, stands, or forest types is divided for classification and use; forest inventories commonly group trees into 20-year age classes.

allospecies: A group within one species composed by differences caused by territorial spread. They are becoming a species on there own.

Biogeoclimatic Ecosystem Classification: A hierarchical ecosystem classification system which has three levels of integration—regional, local, and chronological—and which combines climatic, vegetation, and site factors.

biogeoclimatic units: Units of a hierarchical ecosystem classification system having three levels of integration—regional, local, and chronological—and combining climatic, vegetation, and site factors.

biological diversity: The diversity of plants, animals, and other living organisms in all their forms and levels of organization, including the diversity of genes, species, ecosystems, and evolutionary and functional processes that link them.

Blue List: A list, prepared by the Ministry of Sustainable Resource Management, Conservation Data Centre, of elements considered to be vulnerable in British Columbia. Vulnerable elements are of special concern because of characteristics that make them particularly sensitive to human activities or natural events. Blue-listed elements are at a lower level of risk than red-listed elements.

broad ecosystem unit: A permanent area of the landscape, meaningful to animal use, that supports a distinct kind of dominant vegetative cover, or distinct non-vegetated cover. These units are defined as including potential (climax) vegetation and any associated successional stages (for forests and grasslands).

coarse woody debris: Decaying wood on the ground that provides special microclimates and breeding habitat for a wide variety of organisms.

COSEWIC: An organization comprised of representatives from each provincial and territorial government wildlife agency which determines the national status of wild species, subspecies, varieties, and nationally significant populations that are considered to be at risk in Canada.

costal grooves: A series of vertical grooves on the sides of salamanders, between the fore- and hind limb.

deactivate: Road deactivation is an engineering issue that involves application of techniques to stabilize the road prism, restore or maintain the natural drainage patterns, and minimize sediment transport to protect neighbouring resources at risk from potential landslide and sedimentation events.

desired plant community: A plant community that produces the kind, proportion, and amount of vegetation necessary for meeting or exceeding the stated objectives for a site according to a range use plan. The desired plant community must be consistent with the capability of the site to produce the vegetation through management, land treatment, or a combination of the two. The desired plant community takes into account multiple values, such as economics, biodiversity, water quality, wildlife/fisheries, forage, and recreation.

diameter at breast height: A measurement taken at approximately breast height (~1.5 m) and used as the standard for describing the diameter of a tree.

ecoprovince: An area with consistent climate or oceanography, relief, and plate tectonics.

ecosection: An area with minor physiographic and macroclimatic or oceanographic variation.

element: A species or a plant community. The term "species" includes all entities at the taxonomic level of species, such as subspecies, plant varieties, and interspecific hybrids.

Endangered: A COSEWIC designation indicating a species facing imminent extirpation or extinction.

epikarst: The uppermost layer of a karstified rock in which a large proportion of the fissures have been enlarged by solutional erosion.

extinct: A species that no longer exists.

follicle: A dry fruit derived from a single carpel, splitting open along the ventral suture at maturity.

fragility: Ability of the plant community to recover from disturbances.

gravid: When females are carrying fertilized eggs.

general wildlife measure: A management practice established for an area, by order, by the Minister of Water, Land and Air Protection, for (a) a category of species at risk, (b) a category of regionally important wildlife, or (c) a category of specified ungulate species.

hyporheic: An area of gravel and other sediments under or next to the streambed with water flowing through.

Identified Wildlife: A subset of species at risk and regionally important wildlife established by the Minister of Water, Land and Air Protection.

Identified Wildlife Management Strategy: A strategy enabled under the *Forest and Range Practices Act* to address the management of Identified Wildlife. The Strategy is comprised of two companion documents: *Accounts and Measures for Managing Identified Wildlife* and *Procedures Framework for Managing Identified Wildlife.*

Indeterminate: A COSEWIC designation for species that have been evaluated, but not enough information about them is available to determine their status.

inflorescence: A cluster of flowers.

instar: An insect stage between molts (growth).

invasive species: Species that are non-native or alien to the ecosystem under consideration, and whose introduction causes or is likely to cause economic or environmental harm or harm to human health.

karst: Terrain, generally underlain by limestone or dolomite (carbonate rocks), in which the topography is formed chiefly by the dissolving of rock, and which may be characterized by sinkholes, sinking streams, closed depressions, subterranean drainage, and caves.

lacustrine: Pertaining to a lake.

large woody debris: Woody debris in a stream, lake, or wetland setting, during at least part of the year, with a diameter of 10 cm or greater and a length of 2 m or greater.

livestock attractant: a substance or structure that draws livestock, including salt/minerals, supplements, water developments and cattle oilers.

Natural Disturbance Type: An area that is characterized by a natural disturbance regime.

NatureServe Explorer: An organization dedicated to providing reliable information on species and ecosystems for use in conservation and land use planning.

neotene: Amphibian larvae that mature to adult size without losing their external gills. They are sexually mature, obligate water-dwelling individuals.

Not at risk: A COSEWIC designation for species that have been evaluated and deemed not currently at risk.

occurrence: A location representing a habitat that sustains or otherwise contributes to the survival of a population (e.g., a south-facing slope that provides winter range for 10 elk would be considered a single occurrence, not 10).

old field: A field that has been left to grow.

old growth management area: A spatially identified area that is subject to old growth management objectives.

ovigerous: Bearing eggs.

oviparous: Reproduces by laying eggs.

ovoviviparous: Reproduces by eggs which remain in the female's body until ready to hatch. When the young emerge, they are born live.

parotid glands: Paired glands in the form of large bumps. In toads, these are located behind the eyes on the neck and secrete toxic substances used for defense.

perigynium: Special sac which encloses the achene in sedges; plural, peryginia.

periphyton: Attached algae.

petal: One of the segments of the corolla of a flower.

pinna: A leaflet or primary division of a pinnate leaf or frond: plural, pinnae.

pinnate: Compound leaf, with leaflets arranged on two sides of a common axis.

plant community: The plant community element, used by the Conservation Data Centre and this guidebook, is based on the plant association concept (V.J. Krajina and students): an abstract unit based on sample plots of climax vegetation that possess similar vegetation structure and native species composition, and occur repeatedly on similar habitats.

platform: With birds, the term is used to describe a nest type that is a flat structure (i.e., for Marbled Murrelets platforms are large limbs or deformities with epiphyte cover).

Predictive Ecosystem Mapping: A method of predicting ecosystem occurrence on the landscape given basic inventory information and expert knowledge.

properly functioning condition: Refers to: the ability of a stream, river, wetland or lake and its riparian area to (a) withstand normal peak flood events without experiencing accelerated soil loss, channel movement or bank movement, (b) filter runoff, and (c) store and safely release water, and when uplands associated with the riparian area exhibit (d) vegetation and biological processes, (e) infiltration rates and moisture storage, and (f) stability that is appropriate to soil, climate and landform.

raceme: An unbranched type of inflorescence presenting a symmetrical display of stalked flowers, with older flowers towards the base.

Red List: A list, prepared by the Ministry of Sustainable Resource Management, Conservation Data Centre, of elements being considered for or already designated extirpated, endangered, or threatened. Extirpated taxa no longer exist in the wild in British Columbia, but occur elsewhere. Endangered taxa are facing imminent extirpation or extinction. Threatened taxa are likely to become endangered if limiting factors are not reversed.

regionally important wildlife: A category of species under FRPA (s.105) established by the Minister of Water, Land and Air Protection, by order, if satisfied that the species a) is important to a region of British Columbia, b) relies on habitat that requires special management that is not otherwise provided for in this regulation, and c) is vulnerable to impacts from forest practices or range practices.

rehabilitation (access measure): Rehabilitation of a road is typically done in accordance with a silviculture prescription or logging plan, and is normally carried out concurrently with, or following, deactivation to restore the affected area to a productive site for growing crop trees.

rhizome: A rootlike subterranean stem, commonly horizontal in position, which usually produces roots below and sends up shoots from the upper surface.

riparian habitat: The area adjacent to a watercourse, lake, swamp, or spring that is influenced by the availability of water and is generally critical for wildlife cover, fish food organisms, stream nutrients, and large organic debris, and for streambank stability.

sepal: One of the individual leaves or parts of the calyx of a flower.

seral stages: The stages of ecological succession of a plant community (e.g., from young stage to old stage). The characteristic sequence of biotic communities that successively occupy and replace each other by which some components of the physical environment become altered over time.

snag: Standing dead or partially dead tree.

snout-vent length: A standard measurement of body length. The measurement is from the tip of the snout to the vent and excludes the tail.

Special Concern: A COSEWIC designation indicating a species of special concern because of characteristics that make it particularly sensitive to human activities or natural events.

Species at risk: A category of species under FRPA (s.105) established by the Minister of Water, Land and Air Protection, by order, if satisfied that the species in the category are endangered, threatened or vulnerable.

stalk: Stem or main axis of a plant.

stigma: Part of the pistil (female organ), which receives the pollen.

structural stage: Describes current vegetation focusing on the age class of the ecosystem in question. Stuctural stage will depend on subzone designation and vegetative species.

supercilium: A line of feathers above the eye.

Terrestrial Ecosystem Mapping: The stratification of a landscape into map units according to a combination of ecological features, primarily climate, physiography, surficial material, bedrock geology, soil, vegetation, and disturbance.

Threatened: A COSEWIC designation indicating a species likely to become endangered if limiting factors are not reversed.

tragus: A flap of skin at the base of the external ear.

watershed assessment procedure: An analytical procedure designed to help forest managers understand the type and extent of current water-related problems that may exist in a watershed, and to recognize the possible hydrological implications of proposed forestry and related development or restoration in that watershed.

wildlife habitat area: The Identified Wildlife Management Strategy provides foresters and ranchers with management practices for managing habitats for Identified Wildlife. The management practices must be followed within areas set aside for a particular species or plant communities. These areas are called "wildlife habitat areas" and are officially designated by the Minister of Water, Land and Air Protection.

wildlife habitat feature: A localized feature established, by order, by the Minister of Water, Land and Air Protection. Includes features such as fisheries sensitive features, marine sensitive features, significant mineral licks or wallows, and Bald Eagle, Osprey, and Great Blue Heron nests.

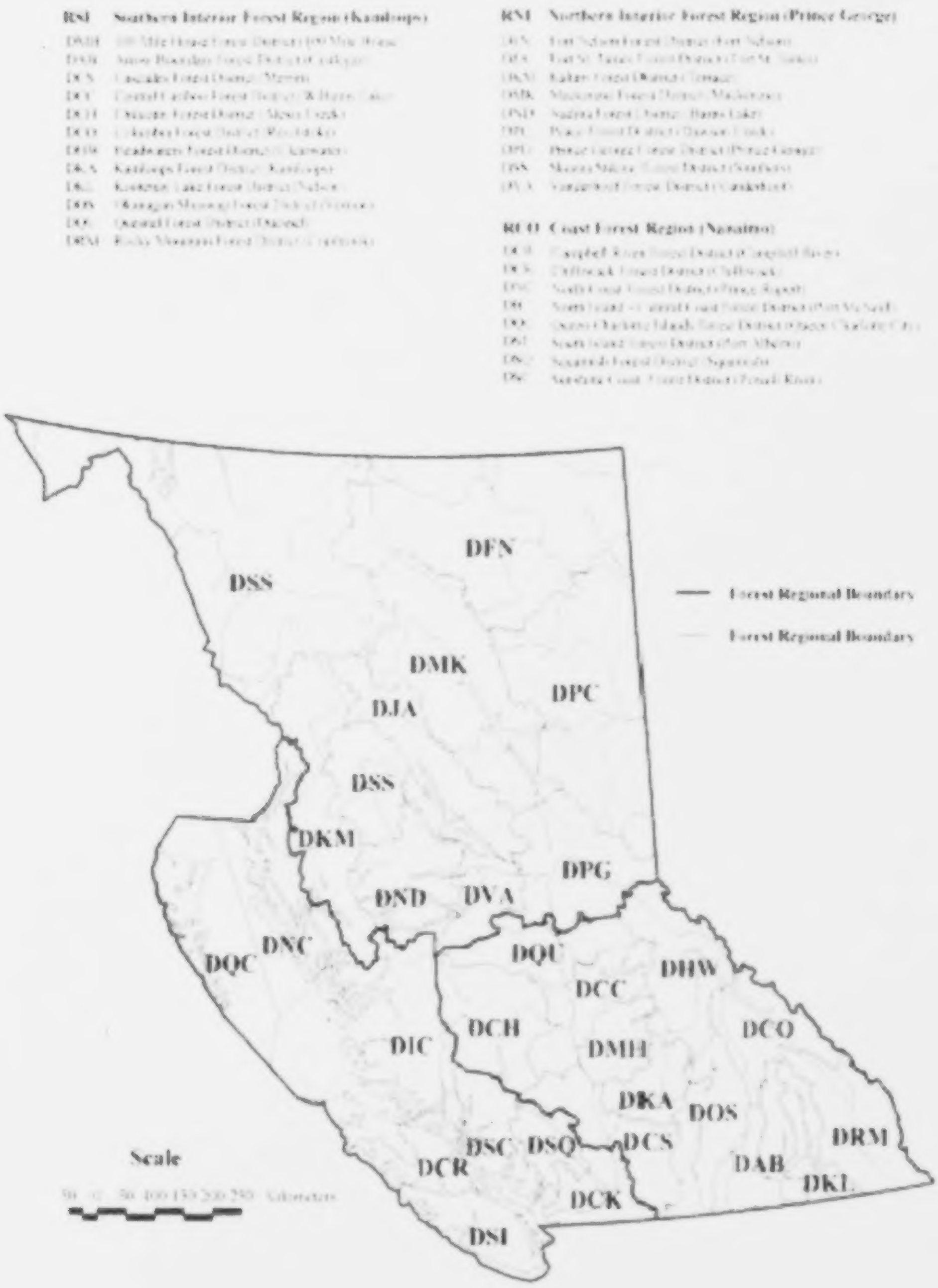
wildlife tree: A standing live or dead tree with special characteristics that provide valuable habitat for the conservation or enhancement of wildlife. Characteristics include large diameter and height for the site, current use by wildlife, declining or dead condition, value as a species, valuable location, and relative scarcity.

wildlife tree retention area: An area specifically identified for the retention and recruitment of suitable wildlife trees. It can contain a single wildlife tree or many.

Yellow List: List of vertebrates that are considered "not at risk" within the province.

Appendix 1. Ministry of Forests administrative boundaries

Forest Region and District Boundaries - April 1, 2003


RSI Southern Interior Forest Region (Kamloops)
RNI Northern Interior Forest Region (Prince George)
RCO Coast Forest Region (Nanaimo)
DFN
DSS
DMK
DPC
DJA
DSS
DKM
DPG
DND
DVA
DQU
DNC
DQC
DHW
DCC
DCH
DCO
DIC
DMH
DKA
DOS
DSC
DSQ
DCS
DRM
DCR
DAB
DKL
DCK
DSI
Forest Regional Boundary
Forest Regional Boundary
Scale
Kilometers

Appendix 2. Ecoprovince and ecosection codes (Version 1.7)

Code	Ecoprovince/Ecosections	Code	Ecoprovince/Ecosections
COM	**Coast and Mountains Ecoprovince**	**SIM**	**Southern Interior Mountains Ecoprovince**
CBR	Central Boundary Ranges	BBT	Big Bend Trench
CPR	Central Pacific Ranges	BOV	Bowron Valley
CRU	Cranberry Upland	CAM	Cariboo Mountains
DIE	Dixon Entrance	CCM	Central Columbia Mountains
EPR	Eastern Pacific Ranges	COC	Crown of the Continent
HEL	Hecate Lowland	CPK	Central Park Ranges
HES	Hecate Strait	EKT	East Kootenay Trench
KIM	Kimsquit Mountains	ELV	Elk Valley
KIR	Kitimat Ranges	EPM	Eastern Purcell Mountains
MEM	Meziadin Mountains	FLV	Flathead Valley
NAB	Nass Basin	FRR	Front Ranges
NAM	Nass Mountains	MCR	McGillivray Ranges
NBR	Northern Boundary Ranges	NKM	Northern Kootenay Mountains
NIM	Northern Island Mountains	NPK	Northern Park Ranges
NPR	Northern Pacific Ranges	QUH	Quesnel Highland
NWC	Northwestern Cascade Ranges	SCM	Southern Columbia Mountains
NWL	Nahwiti Lowland	SFH	Selkirk Foothills
OUF	Outer Fiordland	SHH	Shuswap Highland
QCL	Queen Charlotte Lowland	SPK	Southern Park Ranges
QCS	Queen Charlotte Sound	SPM	Southern Purcell Mountains
QCT	Queen Charlotte Strait	UCV	Upper Columbia Valley
SBR	Southern Boundary Ranges	UFT	Upper Fraser Trench
SKP	Skidegate Plateau	**SOI**	**Southern Interior Ecoprovince**
SPR	Southern Pacific Ranges	GUU	Guichon Upland
VIS	Vancouver Island Shelf	HOR	Hozameen Range
WIM	Windward Island Mountains	LPR	Leeward Pacific Ranges
WQC	Windward Queen Charlotte Mountains	NIB	Nicola Basin
GED	**Georgia Depression Ecoprovince**	NOB	Northern Okanagan Basin
FRL	Fraser Lowland	NOH	Northern Okanagan Highland
GEL	Georgia Lowland	NTU	Northern Thompson Upland
JDF	Juan de Fuca Strait	OKR	Okanagan Range
LIM	Leeward Island Mountains	PAR	Pavilion Ranges
NAL	Nanaimo Lowland	SCR	Southern Chilcotin Ranges
SGI	Southern Gulf Islands	SHB	Shuswap Basin
SOG	Strait of Georgia	SOB	Southern Okanagan Basin
SAL	**Southern Alaska Mountains Ecoprovince**	SOH	Southern Okanagan Highland
ALR	Alsek Ranges	STU	Southern Thompson Upland
ICR	Icefield Ranges	THB	Thompson Basin
		TRU	Tranquille Upland

Code	Ecoprovince/Ecosections
CEI	**Central Interior Ecoprovince**
BUB	Bulkley Basin
BUR	Bulkley Ranges
CAB	Cariboo Basin
CAP	Cariboo Plateau
CCR	Central Chilcotin Ranges
CHP	Chilcotin Plateau
FRB	Fraser River Basin
NAU	Nazko Upland
NEU	Nechako Upland
QUL	Quesnel Lowland
WCR	Western Chilcotin Ranges
WCU	Western Chilcotin Upland
TAP	**Taiga Plains Ecoprovince**
ETP	Etsho Plateau
FNL	Fort Nelson Lowland
MAU	Maxhamish Upland
MUP	Muskwa Plateau
PEP	Petitot Plain
TLP	Trout Lake Plain
SBI	**Sub-Boreal Interior Ecoprovince**
BAU	Babine Upland
ESM	Eastern Skeena Mountains
HAF	Hart Foothills
MAP	Manson Plateau
MCP	McGregor Plateau
MIR	Misinchinka Ranges
NEL	Nechako Lowland
NHR	Northern Hart Ranges
NSM	Northern Skeena Mountains
PAT	Parsnip Trench
PEF	Peace Foothills
SHR	Southern Hart Ranges
SOM	Southern Omineca Mountains
SSM	Southern Skeena Mountains
BOP	**Boreal Plains Ecoprovince**
CLH	Clear Hills
HAP	Halfway Plateau
KIP	Kiskatinaw Plateau
PEL	Peace Lowland
NBM	**Northern Boreal Mountains Ecoprovince**
CAR	Cassiar Ranges
EMR	Eastern Muskwa Ranges
HYH	Hyland Highland
KEM	Kechika Mountains
KLR	Kluane Ranges
LIP	Liard Plain
MUF	Muskwa Foothills
NOM	Northern Omineca Mountains
SBP	Southern Boreal Plateau
SIU	Simpson Upland
STH	Stikine Highland
STP	Stikine Plateau
TAB	Tatshenshini Basin
TAH	Tagish Highland
TEB	Teslin Basin
TEP	Teslin Plateau
THH	Tahltan Highland
TUR	Tuya Range
WHU	Whitehorse Upland
WMR	Western Muskwa Ranges

Appendix 3. Biogeoclimatic ecological classification unit codes

Code	Zone
AT	Alpine Tundra
BG	Bunchgrass
BWBS	Boreal White and Black Spruce
CDF	Coastal Douglas-fir
CWH	Coastal Western Hemlock
ESSF	Engelmann Spruce–Subalpine Fir
ICH	Interior Cedar-Hemlock
IDF	Interior Douglas-fir
MH	Mountain Hemlock
MS	Montane Spruce
PP	Ponderosa Pine
SBPS	Sub-Boreal Pine–Spruce
SBS	Sub-Boreal Spruce
SWB	Spruce–Willow–Birch

Subzones are designated by 2 letters. The first letter indicates the precipitation regime:

x	very dry
d	dry
m	moist
w	wet
v	very wet

The second letter indicates continentality on the coast (CWH and MH):

h	hypermaritime
m	maritime
s	submaritime

and temperature regime in the interior (all other zones):

h	hot
w	warm
m	mild
k	cool
c	cold
v	very cold

For example,

CWHwh	Coastal Western Hemlock wet hypermaritime subzone
IDFww	Interior Douglas-fir wet warm subzone
BGxh	Bunchgrass very dry hot subzone

Appendix 4. Broad ecosystem units of British Columbia

Adapted from *Standards for Broad Terrestrial Ecosystem Classification and Mapping for British Columbia: Classification and Correlation of the Broad Habitat Classes used in 1:250,000 Ecological Mapping* (RIC 1998). See http://srmwww.gov.bc.ca/risc/pubs/teecolo/bei/assets/bei.pdf for more detailed descriptions.

Code	Name[1]	Description	BEC units
AB	Antelope-brush Shrub/ Grassland	Typically an open to dense, dry shrubland, generally lacking trees, that is dominated by drought-tolerant shrubs, most prominently antelope-brush and perennial grasses. Found at lower elevations, between 250 and 700 m; limited to the southern portion of the Okanagan Valley, mainly south of Penticton, extending to the U.S. border.	*BGxh1 PPxh1 PPdh2*
AC	Trembling Aspen Copse	Typically a dense deciduous or broad-leaved forest with a shrub-dominated understorey which includes plant communities that succeed through shrub thickets to an edaphic climax of trembling aspen; found in association with shrub/grasslands or grasslands. Found at lower elevations, between 330 and 1150 m, throughout the major river valleys of the Fraser Plateau and the Thompson–Okanagan Plateau, as well as in the Okanagan Valley and portions of the East Kootenay Trench.	*BGxw1 BGxw2 IDFdk1 IDFdk3 IDFdk4 IDFxh1 IDFxh2 IDFxm PPdh2 PPxh1 SBPSmk SBPSxc*
AD	Sitka Alder – Devil's-club Shrub	Typically a Sitka alder shrub community with a lush fern understorey, which occurs on steep slopes within the northern portion of the Interior Cedar-Hemlock zone. Typically found at lower elevations, between 150 and 1000 m, on the leeward side of the Coast Mountains, in river valleys.	*ESSFwk1 ICHmc1 ICHvc ICHwc*
AG	Alpine Grassland	Typically a high elevation, northern, grassland habitat, characterized by lush bunchgrass growth, with forbs, sedges, and terrestrial lichens. This unit is only found in the alpine tundra (AT) zone in most of the mountain ranges in the province.	
AH	Alpine Heath	Typically a high elevation dwarf shrubland habitat, characterized by cold resistant vegetation, consisting of mountain-heathers, forbs, graminoids, and lichens. This unit is only found in the alpine tundra (AT) zone in most of the mountain ranges in the province.	
AM	Alpine Meadow	Typically a high elevation, herbaceous community, dominated by moisture-loving forbs and/or sedges, on wetter sites in alpine areas. This unit is only found in the alpine tundra (AT) zone in most of the mountain ranges in the province.	

---

[1] Broad ecosystem unit names contain the dominant and/or characteristic climax and seral species.

Code	Name[1]	Description	BEC units
AN	Alpine Sparsely Vegetated	Typically a high elevation, sparsely vegetated habitat, characterized by a mixture of rocky slopes and a sparse cover of grasses, lichens, and low shrubs. This unit is only found in the alpine tundra (AT) zone in most of the mountain ranges in the province.	
AS	Alpine Shrubland	Typically a high elevation, shrubland habitat, characterized by a dense cover of deciduous shrubs with graminoids, forbs, and terrestrial lichens. This unit is only found in the alpine tundra (AT) zone in most of the mountain ranges in the province.	
AT	Alpine Tundra	Typically a high elevation, open to dense herbaceous or dwarf shrubland habitat, characterized by cold-resistant vegetation consisting of low dwarf shrubs, graminoids, hardy forbs, and lichens. This unit is only found in the alpine tundra (AT) zone in most of the mountain ranges in the province.	
AU	Alpine Unvegetated	Typically a high elevation habitat dominated by rock outcrops, talus, steep cliffs, and other areas with very sparse vegetation of grass, lichens, and low shrubs. This unit is only found in the alpine tundra (AT) zone of the mountain ranges in the province.	
AV	Avalanche Track	Typically a dense shrub- or herb-dominated ecosystem where periodic snow and rock slides have prevented coniferous forest establishment, and abundant moisture is available for much of the growing season. Avalanche tracks characteristically begin in the alpine or subalpine zones where there is abundant snow accumulation and steeply sloping valley walls. There are no definite elevational limits, upper or lower. Slope breaks and snow accumulation determine the downslope extent of each avalanche track.	*AT CWHds1* *CWHds2* *CWHmm2* *CWHms2* *CWHvm1* *CWHvh2* *CWHvm2* *CWHwm* *CWHws2* *CWHxm* *MHmm1 MHmm2* *BWBSdk* *BWBSmw* *BWBSvk* *BWBSwk* *ESSFdc ESSFdk* *ESSFmc ESSFmk* *ESSFmm ESSFmv* *ESSFmw ESSFvc* *ESSFwc ESSFwk* *ESSFwm ESSFwv* *ESSFxc ESSFxv* *ICHmc ICHmk* *ICHmm ICHmw* *ICHvc ICHvk1* *ICHwc ICHwk* *IDFww MHmm1* *MHmm2 MHwh* *MSdk MSxv* *SBPSmc SBSdh* *SBSmc SBSmk* *SBSvk SBSwk* *SWBdk SWBmk*

Code	Name[1]	Description	BEC units
BA	Boreal White Spruce –Trembling Aspen	Typically a dense, broad-leaved, mixed, or coniferous mixed forest with shrub- and herb-dominated understories, which includes plant communities that succeed through trembling aspen seral forests to a white spruce climax. Found in the northeastern portion of the province, from the intersection of the Rocky Mountains and the Alberta border north to the Yukon and Northwest Territories. Found at lower elevations, between 300 and 1050 m, in the more northerly locations. In the southern portions, it occurs at higher elevations, between 750 and 1050 m.	*BWBSmw1* *BWBSmw2*
BB	Black Spruce Bog	A bog wetland class that typically is a sparse to open, treed organic wetland, with a peat moss-dominated understorey, black spruce and sometimes, tamarack. Found at low to mid-elevations, between 300 and 1250 m. It is common throughout the Taiga and Boreal Plains, Northern Boreal Mountains, Sub-Boreal Interior, Nass Basin, Southern Rocky Mountain Trench, and Fraser Plateau.	*BWBSdk1* *BWBSdk2* *BWBSmw1* *BWBSmw2* *BWBSwk1* *BWBSwk2* *BWBSwk3* *ICHmc2 ICHmm* *ICHvk2 ICHwk3* *SBPSdc SBPSmc* *SBPSmk SBSdh* *SBSdk SBSdw2* *SBSmk1 SBSdw3* *SBSmc2 SBSmc3* *SBSmw SBSvk* *SBSwk1 SWBmk*
BG	Sphagnum Bog	A bog wetland class that typically is an unforested wetland, dominated by sphagnum mosses and herbaceous plants, found on poorly drained organic sites. Found throughout the province in poorly drained, wet sites, typically areas that are level or depressional. This very localized habitat is found at elevations ranging from sea level on the north coast to higher elevations (< 1800 m) in the Northern Interior. It is found at much higher elevations in the Southern Interior, usually above 1200 m.	
BK	Subalpine Fir – Scrub Birch Krummholz	Typically a northern, high elevation, stunted tree, open habitat, characterized by islands of subalpine fir intermixed with a dense shrub cover of willows and scrub birch. This unit is found at elevations above the upper limit of the Spruce–Willow–Birch (SWB) zone, approximately 1500 m and below the Alpine Tundra (AT) zone. It occurs throughout the subalpine areas of the Northern Boreal Mountains; small patches are also present in the Northern Omineca and Central Canadian Rocky Mountains, as well as on the Muskwa Plateau.	*SWBdk SWBmk* *SWBun*
BL	Black Spruce – Lodgepole Pine	Typically an open coniferous forest with shrub, moss, or terrestrial lichen understories, on gently sloping dry or wet sites, usually with lodgepole pine communities that progress to a black spruce climax. Generally found in the northern half of the province, north of 53 N. Located throughout the region east of the Rocky Mountains to	*BWBSdk1* *BSBSdk2* *BWBSmw1* *BWBSmw2* *BWBSwk1* *BWBSwk2*

Code	Name[1]	Description	BEC units
		the Alberta border and north to the Northwest Territories. It is also found at lower to mid-elevations of the major river valleys in the Skeena, Omineca, and Central Rocky Mountains, as well as in the Fraser Basin, Rocky Mountain Trench, and northern portions of the Fraser Plateau. Typically, the elevation ranges between 350 and 1200 m. The majority of sites are located in cool areas, either low-lying valley floors or on north-facing slopes.	*SBPSdc SBPSmc* *SBSdw2 SBSdw3* *SBSmc2 SBSmc3* *SBSmk1 SBSmk2* *SBSwk1 SBSwk2* *SBSwk3*
BP	Boreal White Spruce – Lodgepole Pine	Typically a dense, boreal coniferous forest which includes plant communities that succeed through lodgepole pine seral forests to a white spruce climax. Found at elevations ranging from 300 to 1200 m throughout the northeastern plains, north of the Rocky Mountain/Alberta border intersection to the Northwest Territories. It also occurs extensively along the walls of major valleys in the northern Boreal Mountains, including the Northern Rocky Mountains, Cassiar Ranges, St. Elias Mountains, and all of the adjacent plateaus.	*BWBSdk1* *BWBSdk2* *BWBSmw1* *BWBSwk1* *BWBSwk2* *BWBSwk3*
BS	Bunchgrass Grassland	Typically a dense herbaceous habitat dominated by perennial grasses and forbs and generally lacking shrubs or trees. Found at elevations ranging from 300 to 1650 m depending on the amount of moisture present. This unit occurs extensively throughout the lower to mid-elevations of the Southern Interior and southern portion of the Fraser Plateau; including the Fraser River, Thompson and Okanagan basins, as well as the valleys around the Fraser River in the Pavilion Ranges, the Nicola River, and the Similkameen River. More isolated ecosystems are also found in the Granby and Kettle River valleys of the Southern Okanagan Highland and in portions of the East Kootenay Trench.	*BGxh1 BGxh2* *BGxh3 BGxw1* *BGxw2 ESSFxc* *IDFdk1 IDFdk3* *IDFdk4 IDFdm1* *IDFxh1 IDFxh2* *IDFxm MSxk* *PPdh1 PPdh2* *PPxh1 PPxh2* *SBPSdc SBPSmk* *SBPSxc SBSdk*
CB	Cedars – Shore Pine Bog	A bog wetland class that typically is an open to dense forest, with moss- and shrub-dominated understories. Sites are found in poorly drained outer coastal areas; often containing a varying mixture of western hemlock, western redcedar, yellow-cedar, and shore pine. Found at lower elevations throughout the coast and mountains, as well as the Georgia Depression, ranging from sea level to 1100 m.	*CDFmm CWHdm* *CWHds1 CWHds2* *CWHmm1* *CWHmm2* *CWHms1* *CWHms2* *CWHvh1* *CWHvh2* *CWHvm1* *CWHvm2* *CWHwh1* *CWHwm* *CWHws1* *CWHws2* *CWHxm*
CD	Coastal Douglas-fir	Typically a dense coniferous forest with shrub-dominated understories, including seral plant communities composed of Douglas-fir, which progress directly to climax. Occurs from sea level to ~ 700 m in southwest B.C. including the Gulf Islands, and Vancouver Island, east of the Vancouver Island Ranges and south of Kelsey Bay. It is also found in a narrow strip along the Mainland Coast,	*CDFmm CWHdm* *CWHds1* *CWHmm1* *CWHxm* *CWHds2* *CWHmm2*

Code	Name[1]	Description	BEC units
		south of Bella Coola and in the southern portion of the Fraser Valley as well as east and north of Chilliwack into the drainages of the upper Fraser River and the eastern Coast Mountains.	
CF	Cultivated Field	Typically a mixture of farmlands where human agricultural practices of plowing, fertilization, and non-native crop production have resulted in long-term soil and/or vegetation changes. Generally, cultivated fields are located on flat to gently rolling terrain. Soil types and local climatic factors influence the types of crops that can be grown. The majority of the lower elevation plateaus and floodplains in the province are used for agriculture.	
CG	Coastal Western Redcedar – Grand Fir	Typically a dense coniferous forest which includes plant communities that progress through long-lived Douglas-fir seral stages to a varied climax of western redcedar and grand fir. Restricted to low elevations (sea level to ~150 m) along southeastern Vancouver Island from Bowser to Victoria, the Gulf Islands south of Cortes Island, and a narrow strip along the Sunshine Coast.	*CDFmm*
CH	Coastal Western Hemlock – Western Redcedar	Typically a dense coniferous forest, with shrub-dominated understories, found along outer coastal plains. Occurs in a narrow fringe (sea level to 600 m) along the outer coast of southern Vancouver Island widening to cover the northern portion of Vancouver Island, the windward side of the Queen Charlotte Ranges, and the Coast Mountains up the Mainland Coast to the Alaskan border.	*CWHmm1* *CWHmm2* *CW*[illegible]*1 CWHvh2* *CWHvm1* *CWHvm2* *CWHwh1* *CWHwh2*
CL	Cliff	Non-alpine, steep unvegetated rock slope. Cliffs are typically located throughout the province, mainly concentrated in mountainous regions. Cliffs are most often associated with many of the alpine units as well as the talus and rocky outcrop units.	
CP	Coastal Douglas-fir –Shore Pine	Typically a dry coniferous forest, characterized by plant communities composed of a sparse shrub layer and a well-developed moss and lichen layer, which proceeds to a Douglas-fir climax. Typical elevation ranges from sea level to approximately 650 m. This unit is found along the Sunshine Coast and in the lower Fraser Valley, extending inland along the major river valleys to its eastern limit in the Coast Mountains.	*CWHds1 CWHds2* *CWHms1* *CWHms2*
CR	Black Cottonwood Riparian Habitat Class	Typically a dense conifer and deciduous or broad-leaved forest with shrub-dominated understories, which includes plant communities that progress through a varying mixture of shrubs and black cottonwood. Found throughout the province along major rivers where floodplains occur, ranging in elevation from sea level to approximately 600 m.	*CDFmm CWHdm* *CWHds1* *CWHds2* *CWHmm1* *CWHvm1* *CWHxm BGxh1* *BGxh2 BGxw2* *BGxh3 ICHmc1* *ICHmc2 ICHvc* *ICHwc IDF PPdh1* *PPxh2*

Code	Name[1]	Description	BEC units
CS	Coastal Western Hemlock –Subalpine Fir	Typically a northern coastal, cold habitat, characterized by dense coniferous forests of western hemlock, subalpine fir, and spruce with dense shrub, moss, and lichen layers. Occurs in the Coast, Skeena, and Hazelton mountains, the Nass Basin, and the Stikine Plateau; ranging between 100 and 1100 m in elevation.	*ICHmc1 ICHmc1a ICHmc2 ICHvc ICHwc*
CW	Coastal Western Hemlock –Douglas-fir	Typically a dense coniferous forest with fern- or shrub-dominated understories, which includes plant communities that progress through long-lived Douglas-fir seral stages to a western hemlock climax. Found in lower to mid-elevations, ranging from sea level to approximately 700 m, in the southwestern portion of the province.	*CWHdm CWHds1 CWHds2 CWHxm*
DA	Douglas-fir – Arbutus	Typically a dense coniferous forest with shrub-dominated understories, whose plant communities may pass through seral stages with arbutus as a major component after intense fire, to a Douglas-fir climax. Occurs on the eastern side of Vancouver Island south of Kelsey Bay, on the Southern Gulf Islands, and on some of the islands located in Johnstone Strait. It also occurs in the lower Fraser Valley on the south side of the Fraser River as far as Chilliwack and along the Sunshine Coast up to Desolation Sound. It ranges in elevation from sea level to approximately 700 m.	*CDFmm CWHdm CWHxm*
DF	Interior Douglas-fir Forest	Typically a dense coniferous forest with grass- or shrub-dominated understories, which includes plant communities that progress directly to a Douglas-fir climax. Occurs in the Southern Interior at low to moderate elevations in the Interior Douglas-fir biogeoclimatic zone. Elevational limits range between 700 and 1100 m.	*BGxh3 BGxw2 IDFdk1 IDFdk2 IDFdk3 IDFdk4 IDFdm1 IDFdm2 IDFmw1 IDFmw2 IDFxh2 IDFxm IDFxw IDFww SBPSmk SBSdk SBSdw1 SBSdw2 SBSmc1 SBSmh ICHmk1 ICHmk2 ICHmw3 ICHxw MSdk MSdm1 MSdm2 MSxk*
DL	Douglas-fir – Lodgepole Pine	Typically a dense coniferous forest with shrub- or pinegrass-dominated understories, which includes plant communities that progress through a mixture of lodgepole pine and Douglas-fir or trembling aspen to a Douglas-fir climax. Found at lower to middle elevations (between 400 and 1600 m) throughout the central and Southern Interior.	*ICHmk1 ICHmk2 ICHmw1 ICHmw2 ICHmw3 IDFdk1 IDFdk2 IDFdk3 IDFdk4 IDFww IDFdm1 IDFdm2 MSdc MSdm1 MSdm2 MSxk SBSdh SBSdw1 SBSdw2 SBSdw3 SBSmh SBSmm SBSmw SBPSmk SBPSxc*

Code	Name[1]	Description	BEC units
DP	Douglas-fir – Ponderosa Pine	Typically an open to dense coniferous forest with shrub- or bunchgrass-dominated understories, which includes plant communities that progress through a mixture of Douglas-fir and ponderosa pine to a Douglas-fir climax. Occurs at low elevations in the valleys of the Southern Interior, including the Okanagan and Nicola valleys, as well as the valleys of the North and South Thompson, Bonaparte, Fraser, Similkameen, Kettle, and Granby rivers. Typically found at elevations ranging between 450 and 1300 m.	*ICHdw ICHxw IDFmw1 IDFdk1 IDFdk2 IDFdm1 IDFdm2 IDFxh1 IDFxh2 IDFxw PPxh1 PPdh1 PPxh2*
EF	Engelmann Spruce – Subalpine Fir Dry Forested	Typically a dense coniferous forest with shrub-dominated understories, which includes plant communities that may progress through seral lodgepole pine to a varied climax of Engelmann spruce and subalpine fir. In the southern and central Interior of the province, this unit represents the highest elevation forested area. It occurs throughout the Coast Mountains and eastward into the Rocky Mountains, ranging in elevation between 1275 and 2050 m. There is considerable range in upper and lower elevational limits due to climatic and topographic variability.	*ESSFdc1 ESSFdc2 ESSFdk ESSFdv ESSFmc ESSFmm1 ESSFmk ESSFmw ESSFmv1 ESSFmv2 ESSFmv3 ESSFmv4 ESSFwc1 ESSFwc2 ESSFwc3 ESSFwc4 ESSFwk1 ESSFwk2 ESSFwm ESSFvv ESSFwv ESSFxc ESSFxv MSdc*
ER	Engelmann Spruce Riparian	Typically a dense coniferous forest, with shrub- and forb-dominated understories, Engelmann spruce and sometimes black cottonwood; found on floodplains or small riparian areas. Occurs on floodplains and riparian areas throughout the central, southern, and sub-boreal Interiors, as well as in the Southern Interior Mountains and the eastern slopes of the Coast Mountains. Elevational limits range between 1200 and 2000 m in the south, and 900 and 1500 m in the north.	*ESSFdc1 ESSFdk ESSFdv ESSFmc ESSFmk ESSFmm1 ESSFmv1 ESSFmv2 ESSFmv3 ESSFmv4 ESSFmw ESSFvc ESSFwc1 ESSFwc2 ESSFwc3 ESSFwc4 ESSFwk1 ESSFwk2 ESSFwm ESSFwv ESSFxc ESSFxv*

Code	Name[1]	Description	BEC units
ES	Estuary	Typically an unforested tidal wetland dominated by persistent emergent herbaceous species, with open sporadic access to ocean areas and where the seawater is periodically diluted with fresh water derived from land drainage. Estuaries occur along coastal B.C. where perennial rivers flow into the ocean.	*CDFmm CWHdm CWHmm1 CWHms2 CWHvh1 CWHvh2 CWHvm1 CWHwh1 CWHwm CWHws1 CWHxm1 CWHxm2*
EW	Subalpine Fir – Mountain Hemlock Wet Forested	Typically a dense coniferous forest with shrub-dominated understories, which includes plant communities that progress directly to a mixed climax of subalpine fir, mountain hemlock, and sometimes amabilis fir. Generally found in the eastern Kitimat ranges, south/central Hazelton Mountains, southeast Boundary ranges, and northwest Skeena Mountains. The elevational limits range between approximately 900 and 1800 m. There is also a limited amount of this unit on the leeward side of the Pacific ranges as well as in the western Monashee Mountains, between 1275 and 1675 m.	*ESSFmk ESSFmw ESSFvc ESSFvv ESSFwv*
FB	Subalpine Fir – Scrub Birch Forested	Typically a northern, subalpine, open forested habitat, characterized by stands of subalpine fir and white spruce with a dense shrub understorey of willows and scrub birch. This unit is limited to elevations ranging between 1050 and 1500 m. It occurs in the subalpine areas of the Northern Boreal Mountains including the Northern Omineca, Cassiar, St. Elias, and Northern Rocky Mountains, as well as the Stikine, Teslin, and Southern Boreal plateaus.	*BWBSdk1 BWBSdk2 BWBSvk SWBdk SWBmk SWBvk*
FE	Sedge Fen	A fen wetland class is typically an unforested wetland, dominated by sedges, found on poorly drained organic sites. This very localized ecosystem unit generally occurs in small patches throughout all forested zones within the province. It is most commonly found on the interior plateaus and does not occur in the AT zone.	
FP	Engelmann Spruce – Subalpine Fir Parkland	Typically a high elevation mosaic of stunted-tree clumps and herb- or dwarf shrub-dominated openings, occurring above closed forest ecosystems and below the alpine communities. In the southern and central Interior of the province, this unit represents the transition between the Engelmann Spruce – Subalpine Fir (ESSF) and Alpine Tundra (AT) zones. It occurs throughout the Coast Mountains and eastward into the Rocky Mountains, usually present above the ESSF zone (approximate elevation 2050 m). Note that there is considerable range in the upper and lower elevational limits due to climatic variability and differing topography.	*ESSFdc ESSFdk ESSFdv ESSFmc ESSFmm1 ESSFmm2 ESSFmv1 ESSFmv2 ESSFmv3 ESSFwc1 ESSFwc2 ESSFwc3 ESSFvc ESSFwk1 ESSFwk2 ESSFwm ESSFxc ESSFxv*

Code	Name[1]	Description	BEC units
FR	Amabilis Fir – Western Hemlock	Typically a low elevation, dense coniferous forest with fern- or shrub-dominated understories, which includes plant communities that may contain western redcedar as a long-lived seral species, leading to a mixed western hemlock and amabilis fir climax. Commonly occurs at low to middle elevations, between 500 and 1100 m, occasionally down to sea level. This unit is found extensively throughout the major valleys of the windward and leeward portions of the Coast Mountains, Vancouver Island Ranges, and Queen Charlotte Ranges, as well as on the outer coast of southern Vancouver Island and the adjacent northern Gulf Islands.	*CWHmm1* *CWHmm2* *CWHms1* *CWHms2* *CWHvh1 CWHvh2* *CWHvm1* *CWHvm2* *CWHws1* *CWHws2* *ICHmc1a*
FS	Fast Perennial Stream	Typically a freshwater riverine habitat contained within a channel that has continuously moving, fast flowing water, that is bounded by banks or upland habitat and has a high gradient. Distributed throughout the province with a larger proportion of fast flowing streams found at higher altitudes where there is a larger gradient.	
GB	Gravel Bar	Typically a level, unvegetated, or partially vegetated fluvial area along an active watercourse. Found extensively along streams and rivers throughout the province.	
GL	Glacier	Typically a field or body of snow or ice formed in higher elevations in mountainous terrain where snowfall exceeds melting: these areas of snow and ice will show evidence of past or present glacier movement. Glaciers are generally found above 1800 m in the higher elevation biogeoclimatic zones throughout the mountain ranges of the province.	*AT BWBSdk1* *CWHds1* *CWHwm* *CWHws2* *ESSFmm1* *ESSFmw ESSFxv* *MHmm2 SWBdk* *SWBmk SWBvk*
GO	Garry Oak	Typically a sparse to open mixed forest, with understories dominated by mosses and a dense mixture of spring wildflowers and grasses growing on shallow, rocky sites. This ecosystem is very limited in distribution, occurring at low elevations along southeast Vancouver Island and the Gulf Islands. Elevational limits range between sea level and approximately 150 m.	*CDFmm*
HB	Coastal Western Hemlock – Paper Birch	Typically a dense mixed forest composed of paper birch, Douglas-fir, western redcedar, and western hemlock with shrub-dominated understories. Occurs at low elevations in submaritime and subcontinental areas north of Knight Inlet, ranging in elevation from valley bottom to approximately 500 m.	*CWHds1 CWHds2*
HL	Coastal Western Hemlock – Lodgepole Pine	Typically an open to dense coniferous forest situated on dry sites with shrub-dominated understories, which includes plant communities that progress through lodgepole pine seral stages to a western hemlock climax. This very uncommon ecosystem type is limited to dry ridgecrests and rocky outcrops along the outer coast to the Alaskan border, including Vancouver Island, the Queen Charlotte Islands, and any of the small coastal islands. It can also be found throughout the coast, western Hazelton, and Skeena mountains, and the Nass Basin. It ranges in elevation between sea level and 1000 m.	*CWHvh1 CWHvh2* *CWHvm1* *CWHvm2* *CWHws1* *CWHws2 ICHwc*

Code	Name[1]	Description	BEC units
HP	Mountain Hemlock Parkland	Typically a high elevation, sparse to open mosaic of stunted tree clumps and herbaceous or mountain-heatherdominated openings, that proceeds after disturbance directly to a climax species mix dominated by mountain hemlock. Found at high elevations along the coast, this unit represents the transition between the Mountain Hemlock (MH) and Alpine Tundra (AT) zones. When present, it occurs above the MH zone on the eastern and western slopes of the Vancouver Island Ranges, Queen Charlotte Mountains, and Coast Mountains, as well as the western slopes of the Hazelton Mountains; elevation approximately 1600 m. Note there is considerable range in the upper and lower elevational limits due to climatic variability and differing topography.	*MHmm1 MHmm2* *MHwh*
HS	Western Hemlock – Sitka Spruce	Typically a dense coniferous forest along outer coastal sites with shrub-dominated understories, which usually succeeds directly to a mixed climax of western hemlock and Sitka spruce. Occurs along the west and north coast of Vancouver Island and the Queen Charlotte Islands. It is also found throughout the windward portion of the Coast Mountains, extending from Knight Inlet northward into the Boundary Ranges. Typically this unit occurs at elevations ranging between sea level and approximately 600 m.	*CWHds2* *CWHvh1* *CWHvh2* *CWHwh1* *CWHwh2* *CWHwm*
IG	Interior Western Redcedar	Typically a dense coniferous or mixed forest with extensive shrub- and herb-dominated understories, which includes plant communities that progress through seral Douglas-fir, trembling aspen, and paper birch to a climax of western redcedar and grand fir. ICHxw has a very limited distribution in B.C. It is only found in middle, lower, and toe slope positions, as well as along the valley floor in the southern extremities of the Selkirk and Purcell mountains. Elevational limits range from 450 to 1100 m.	*ICHxw*
IH	Interior Western Hemlock – Douglas-fir	Typically a dense coniferous forest with various shrub- and herb-dominated understories, which includes plant communities that proceed through Douglas-fir, western larch, western white pine, and/or paper birch seral stages to a mixed climax of western hemlock and western red-cedar. Found extensively at low to middle elevations throughout the Columbia Mountains and Highland. Typically ranges in elevation between approximately 400 and 1400 m.	*ICHdw ICHmm* *ICHmw1 ICHmw2* *ICHmw3 ICHvk1* *ICHvk2 ICHwk1* *ICHwk2 ICHwk3* *ICHwk4*
IM	Intertidal Marine	Typically a habitat that consists of ocean overlying the continental shelf and its associated high energy shoreline, with salinities in excess of 18 ppt and a substrate that is exposed and flooded by tides (includes associated splash zone). This unit occurs along the shores of all coastal islands and the mainland, including major inlets, fjords, bays, and open ocean.	*CDFmm CWHdm* *CWHmm1* *CWHms2* *CWHvh1 CWHvh2* *CWHvm1* *CWHwh1* *CWHwm* *CWHws1* *CWHxm1* *CWHxm2*

Code	Name[1]	Description	BEC units
IN	Intermittent Stream	Typically a freshwater riverine habitat contained within a channel that only periodically has moving water and is bounded by banks or upland habitat. Occurs throughout the province in areas where there is not enough water supply to support perennial flow.	
IS	Interior Western Hemlock – White Spruce	Typically a dense coniferous forest with shrub- and moss-dominated understories, which includes plant communities that may progress through long-lived seral sub-alpine fir, spruce, and lodgepole pine to a climax of western hemlock and western redcedar. Found extensively at low to middle elevations throughout the Columbia Mountains and highlands. Typical range of elevation is between approximately 400 and 1400 m. Small pockets are also present in the Southern Nass Basin and Skeena and Hazelton mountains.	*ICHdw ICHmc2* *ICHmm ICHmk3* *ICHmw1* *ICHmw2* *ICHmw3 ICHvk1* *ICHvk2 ICHwk1* *ICHwk2 ICHwk3* *ICHwk4 ICHxw*
LL	Large Lake	Typically a fresh deepwater habitat that includes permanently flooded lakes, usually found in a topographical depression, lacking emergent vegetation except along shorelines, and usually greater than 60 ha.	
LP	Lodgepole Pine	Typically an open lodgepole pine forest with shrub, moss, or terrestrial lichen understories on level, nutrient-poor, coarse-textured soils. Found extensively between 500 and 1600 m, throughout the interior of the province. It occurs in the Southern Interior Mountains, throughout the Columbia range, in the sub-boreal, central, and Southern Interior, as well as throughout the Fraser Plateau, Fraser Basin, Skeena and Omineca mountains, Thompson-Okanagan Plateau, and the leeside of the Pacific Ranges. It is also common within portions of the Taiga and Boreal Plains and Northern Boreal Mountains, and along the North Coast.	*BWBSdk1* *BWBSdk2* *BWBSmw1* *BWBSmw2* *BWBSwk1* *BWBSwk2* *BWBSwk3* *ICHmc1 ICHmc2* *ICHwk1 IDFdk4* *ESSFdc2* *ESSFmv1* *ESSFwc2 ESSFxc* *ESSFxv1 MSdk* *MSdm2 MSdm1* *MSxv SBPSdc* *SBPSmc SBPSmk* *SBPSxc SBSdh* *SBSdk SBSdw1* *SBSdw2 SBSdw3* *SBSmc1 SBSmc2* *SBSmc3 SBSmk1* *SBSmk2 SBSmm* *SBSmw SBSvk* *SBSwk1 SBSwk2* *SBSwk3*
LS	Small Lake	Typically a fresh deepwater habitat that includes permanently flooded lakes (and sometimes reservoirs), usually 8 to 60 ha in a topographic depression, with most of the water less than 7 m in depth. Small lakes occur throughout the province in small valleys and basins.	

Code	Name[1]	Description	BEC units
ME	Meadow	A meadow wetland class that typically is a lower elevation herbaceous community, dominated by moisture-loving species, on imperfectly to poorly drained mineral soil sites. Occurs, to a limited extent, at lower elevations throughout the southern portion of the province, including Vancouver Island, the Mainland Coast, and Okanagan and Kootenay regions. It is most commonly found within the Fraser Plateau area. Meadows do occur in most southern biogeoclimatic zones, with the exception of the AT zone.	
MF	Mountain Hemlock – Amabilis Fir	Typically a high elevation, dense coniferous forest with shrub-dominated understories, which proceeds after disturbance directly to a climax species mix of mountain hemlock, western hemlock, and amabilis fir. This unit occurs in high elevation areas along the coast, including the eastern and western slopes of the Vancouver Island Ranges, Queen Charlotte Mountains, and Coast Mountains, as well as the western slopes of the Hazelton Mountains. It is limited to elevations ranging between 800 and 1600 m. Note there is considerable range in the upper and lower elevation due to climatic variability and differing topography.	*MHmm1 MHmm2 MHwh*
MI	Mine	Typically an area where mining exploration is presently taking place or where mining has recently been completed. Mining activity occurs in all regions of the province, covering large or small areas, depending on the minerals that are desired and the terrain. Open pit mining is commonly used for mineral extraction. Open pit mines are holes in the ground, varying in size and shape, which are open to the sky and have been created to extract minerals or aggregates (including gravel pits). Mines can also be in the form of complex underground tunnels, with only a few tunnels that actually connect to the surface, often via a central mine shaft. Another common feature associated with mining activity are mine tailings or rubbly mine spoils. These are areas containing the waste rock or overburden that is discarded in the extraction of ore in a mining operation.	
MR	Marsh	A marsh wetland class that typically is permanently or seasonally inundated and that supports an extensive cover of emergent, non-woody vegetation rooting in mineral-rich substrate. Found in a limited extent throughout lower elevation sites in the province. Marshes generally occur below 800 m.	
MS	Montane Shrub/Grassland	Typically a varied mixture of shrubs, thickets, and herbaceous openings found in steep breaks along lower river valleys. This type of habitat occurs in a very limited extent, usually in small patches throughout many of the river valleys in the province. It typically ranges in elevation between 350 and 1200 m.	*BGxh3 BWBSmw1 BWBSdk1 BWBSdk2 IDFxh1 MSxv SBPSdc SBPSmc SBSdk SBSdw2 SBSmc2 SBSmc3*

Code	Name[1]	Description	BEC units
OA	Garry Oak – Arbutus	Typically a sparse to open mixed forest, with understories dominated by mosses and a dense mixture of spring wildflowers and grasses, growing on shallow, rocky sites. Restricted to rocky areas of the Coastal Douglas-fir (CDFmm) and Coastal Western Hemlock (CWHxm1) biogeoclimatic subzones of southern Vancouver Island and adjacent Gulf Islands, and a few sites in the southern portions of the Fraser Valley.	*CDFmm* *CWHxm1*
OV	Orchard/Vineyard	Typically an agricultural area used for growing hard and soft fruit crops, with some form of symmetrical arrangement of the trees, shrubs, or vines. Concentrated in very arid regions of the province including the river valleys of the south Fraser, Thompson, and Similkameen rivers; the Okanagan Valley; and southeastern Vancouver Island. Typically orchards and vineyards are associated with the Coastal Douglas-fir, Interior Douglas-fir, Ponderosa Pine, and Bunchgrass biogeoclimatic zones.	
OW	Shallow Open Water	A shallow open water wetland class that typically is comprised of permanent shallow open water and that lacks extensive emergent plant cover; water is usually less than 2 m in depth, with submerged and floating aquatic plants present. Generally found throughout the province at elevations below 1000 m.	
PB	Lodgepole/Shore Pine Bog	A bog wetland class characterized by a sparse cover of stunted shore pine and poorly drained coastal soils. Shrubs and sphagnum moss dominate the understorey. Typically found along eastern Vancouver Island south of Kelsey Bay, throughout the Lower Mainland and up the Mainland Coast, including the western slopes of the Coast Mountains, Hecate Lowland, Outer Fiordland, Georgia Lowland, and the southern Gulf Islands, as well as the islands of Queen Charlotte Strait and the Strait of Georgia. The elevational limits of this unit range between sea level and 700 m.	*CWHds1 CWHds2* *CDFmm1* *CWHms1* *CWHms2* *CWHxm*
PO	Lodgepole Pine Outcrop	Typically a sparse to open lodgepole pine forest, with understories dominated by moss, lichens, and grasses, growing on shallow, rocky sites. Limited to areas with shallow soils over bedrock, within the Pacific Ranges.	*CWHxm CWHdm* *MSxv SBPSxc*
PP	Ponderosa Pine	Typically a sparse to open coniferous forest with shrub- or perennial grass-dominated understories, which occurs along the grassland/forest borders, leading to a ponderosa pine and Douglas-fir climax. Occurs at low elevations in the major valleys of the Thompson/Okanagan Plateau, including the Thompson and Okanagan basins. It also occurs in the East Kootenay Trench and in the Fraser Valley from north of Lillooet to just south of Lytton. Generally found below 500 m in elevation.	*BGxh1 BGxh2* *BGxw1 IDFxh1* *PPdh1 PPdh2* *PPxh1 PPxh2*

Code	Name[1]	Description	BEC units
PR	White Spruce – Balsam Poplar Riparian	Typically a dense, deciduous, mixed or coniferous forest, with thick shrub understories, found on or in association with fluvial sites; includes plant communities that succeed through deciduous forests to a white (or hybrid white) spruce climax. This unit occurs between 300 and 1200 m in the northern portions of the province, throughout the major river valleys of the Northern Boreal Mountains, Boreal and Taiga Plains, as well as in the Southern Omineca and Central Canadian Rocky mountains.	*BWBSdk1* *BWBSdk2* *BWBSmw1* *BWBSmw2* *BWBSwk1* *BWBSwk2* *SWBdk* *SWBmk* *SWBvk*
RB	Western Redcedar – Paper Birch	Typically a dense coniferous forest with shrub-dominated understories, which includes plant communities that succeed through deciduous seral stages or through Douglas-fir, lodgepole pine, and western larch (sometimes) to a climax of western redcedar and hybrid spruce. Commonly found in valley bottoms and lower slopes between 800 and 1400 m. Distributed throughout the Shuswap, Quesnel, and Okanagan highlands, as well as the North Thompson Upland, Southern Fraser Plateau, Southern Rocky Mountain Trench, and the leeside of the Cascade Mountains.	*ICHdk ICHmk2* *ICHmk3 ICHmw3* *IDFdk2*
RD	Western Redcedar – Douglas-fir	Typically a dense coniferous forest with shrub-dominated understories, which includes plant communities that succeed through Douglas-fir, lodgepole pine, and western larch (sometimes) to a climax of western redcedar. Found at low elevations (300–1200 m) in the Shuswap, Quesnel, and Okanagan Highlands and the southern Fraser Plateau. It also occurs in the southern Rocky Mountain Trench and the southern Monashee and Purcell mountains, as well as in the leeward Pacific range and the southern Chilcotin range.	*ICHdk ICHmk1* *ICHmk3 ICHmm* *ICHmw2 ICHwk4* *IDFmw1 IDFmw2* *IDFww IDFxh2*
RE	Reservoir	Typically a fresh, dammed, deepwater habitat that is permanently flooded, with variable water levels. Found all over the province, mainly at lower elevations.	
RM	Reclaimed Mine	Typically a mined area or mine tailings that have plant communities composed of a mixture of agronomic grasses, forbs, and native plants. Mining activity has taken place in all regions of the province, covering large and small areas, depending on the minerals that were desired and the terrain . Reclaimed mines usually contain a mixture of native and introduced plant species. The density and composition of these communities is related to the age and location of the site, as well as the amount of disturbance that resulted from the mining activities. In some areas of the province, the disturbances caused by mining activities may have provided the ideal conditions for particular native plant species, which have flourished since the operation ceased. However, in other heavily disturbed areas, agronomic species may have been seeded to stabilize the soils and have subsequently dominated these previously mined sites.	

Code	Name[1]	Description	BEC units
RO	Rock	Typically a mixture of gentle to steep, non-alpine bedrock escarpments and outcroppings with little soil development and relatively low vegetative cover. Found anywhere exposed bedrock is located in non-alpine regions of the province. Occurs extensively in mountainous areas.	
RR	Western Redcedar – Black Cottonwood Riparian	Typically a dense coniferous forest with shrub-dominated understories, which includes plant communities that may succeed either through deciduous seral species or directly to a climax of hybrid spruce, western redcedar, and western hemlock. Found extensively throughout valleys of the Southern Interior Mountains and portions of the Northern Thompson Upland and Northern Okanagan Highland, between approximately 400 and 1450 m elevation. It also occurs between 350 and 1100 m in the valleys of the Skeena Mountains, Nass Basin, and Nass Ranges.	*ESSFvc ESSFwc1 ESSFwc2 ICHdk ICHdw ICHmc1 ICHxw ICHmk1 ICHmk2 ICHmk3 ICHmm ICHmw1 ICHmw2 ICHmw3 ICHvk1 ICHwk1 ICHwk2 ICHwk3 ICHwk4 ICHvk2 IDFmw1 IDFmw2 IDFww*
RS	Western Redcedar Swamp	A swamp wetland class that typically is an open forested wetland composed of western redcedar and various conifers, with a skunk cabbage and fern understorey associated with very poorly drained sites. The redcedar swamp is limited in size but has an extensive distribution. It occurs between 400 and 1550 m on the more gentle slopes of the Southern Interior Mountains and portions of the Northern Thompson Upland and Northern Okanagan Highland. It occurs throughout the Coastal Douglas-fir (CDF) and Coastal Western Hemlock (CWH) biogeoclimatic zones of the Coast Mountains and Vancouver Island regions between sea level and approximately 1000 m.	*CDFmm CWHdm CWHds1 CWHds2 CWHmm1 CWHmm2 CWHms1 CWHms2 CWHvh1 CWHvh2 CWHvm1 CWHvm2 CWHwm CWHwh1 CWHwh2 CWHws1 CWHws2 CWHxm ICHmk1 ICHmk2 ICHmk3 ICHmw1 ICHmw2 ICHmw3 ICHvk1 ICHvk2 ICHwk1 ICHwk2 ICHwk3 IDFmw2 IDFww*
SA	Sub-boreal White Spruce – Trembling Aspen	Typically a dense mixed or coniferous sub-boreal forest with shrub- and herb-dominated understories, which includes plant communities that succeed through trembling aspen seral forests to a white spruce climax.	
SB	White Spruce – Paper Birch	Typically a dense, mixed sub-boreal forest with dense shrub-dominated understories, which includes plant communities that succeed through paper birch, trembling aspen, and Douglas-fir seral forests to a white spruce climax. Found on the lower valley slopes and valley bottoms between the elevations of 450 and 1225 m in the Rocky Mountain Trench, Fraser Basin, and northern Fraser Plateau.	*SBSmh*

Code	Name[1]	Description	BEC units
SC	Shrub-Carr	A shrub-carr wetland class that typically is dominated by shrubs, found on poorly drained mineral soil sites. Occurs along stream edges, drainage ways, small depressions, and the perimeters of lakes, ponds, and sedge wetlands in most areas.	
SD	Spruce – Douglas-fir	Typically a dense coniferous forest with soopolallie- or pinegrass-dominated understories, which includes plant communities that progress though a mixture of lodgepole pine, Douglas-fir, and western larch to a white spruce and subalpine fir climax; sometimes with lodgepole pine or trembling aspen present. Located between 600 and 1600 m in the areas around the Nechako, Fraser, and Thompson plateaus, as well as in the Okanagan Highland. It is also located in the southern Rocky Mountains, southern Rocky Mountain Trench, southeastern Purcell and Monashee mountains, as well as the leeside of the Cascade Mountains.	*MSdk MSdm1 SBSdh SBSdk SBSdw1 SBSdw2 SBSdw3 SBSvk IDFdk1 IDFdk2 IDFdk3 IDFdm1 IDFdm2 IDFxh1 IDFxm IDFxw*
SF	White Spruce – Subalpine Fir	Typically a dense, coniferous sub-boreal forest with dense shrub- and moss-dominated understories, which includes communities that progress directly to a white spruce and subalpine fir climax, sometimes with lodgepole pine or trembling aspen. This unit is common throughout the lowland forests found on the Fraser Plateau, Fraser Basin, Nass Basin, Central Canadian Rocky Mountains, Omineca Mountains, Skeena Mountains, and Columbia Highlands. It also occurs to a limited extent in the Southern Rocky Mountain Trench and on the Thompson-Okanagan Plateau. In northerly areas it commonly occurs between 500 and 1200 m elevation, while more southerly locations occur at higher elevations between 1000 and 1650 m.	*ESSFmv3 SBSdh SBSdk SBSdw1 SBSdw2 SBSdw3 SBSmc1 SBSmc2 SBSmc3 SBSmh SBSmk1 SBSmk2 SBSmm SBSmw SBSvk SBSwk1 SBSwk2 SBSwk3 MSdc MSdm1 MSdm2 MSxk ICHdk ICHmk1 ICHmk3 ICHvc ICHwc ICHwk2 ICHwk4*
SG	Subalpine Grassland	Typically a high elevation, lush grassland habitat dominated by perennial grasses and forbs, on dry sites. This uncommon unit occurs on isolated, high elevation sites throughout the Northern Boreal Mountains, Omineca Mountains, Central Canadian Rockies, and Southern Interior Mountains. It is found at elevations ranging between 1000 and 1600 m in the north and approximately 1600 and 2000 m in the south.	*BWBSdk1 SWBmk ESSFdk ESSFmv ESSFxc ESSFxv*
SH	Shrub Fen	A fen wetland class that is typically dominated by shrubs, found on poorly drained organic sites. Common throughout the interior of the province, with the exception of the Bunchgrass (BG), Ponderosa Pine (PP), and Alpine Tundra (AT) zones. Limited to areas that are poorly drained, subhydric, and depressional or level.	

Code	Name[1]	Description	BEC units
SK	Spruce – Swamp	A swamp wetland class that typically is an open forested wetland of spruce with an understorey of skunk cabbage and sparse shrubs, found on very poorly drained sites. Located throughout the interior of the province, east of the Coast Mountains including the Northern Boreal Mountains; Taiga and Boreal plains; central, southern, and sub-boreal Interior; and the Southern Interior Mountains. Generally found at mid-elevations between 400 and 1400 m; more northerly locations may occur at lower elevations while more southerly areas may occur at higher elevations.	*IDFdk3 IDFdk4 SBPSdc SBPSmc SBPSmk SBPSxc BWBSdk1 SBSdw1 SBSmc2 SBSmh SBSvk ICHdk ICHmc2 ICHmk1 ICHmk2 ICHmw3 ICHwk4 ICHvc ICHwk1*
SL	Sub-boreal White Spruce – Lodgepole Pine	Typically a dense, sub-boreal coniferous forest that includes plant communities that succeed through lodgepole pine seral forests to a white spruce climax. This unit occurs extensively in the Southern Rocky Mountain Trench, Fraser Basin, Omineca Mountains, and northern portion of the Fraser Plateau; elevational limits range between 700 and 1400 m. It is also present at higher elevations between 1200 and 1650 m, and in portions of the southern Fraser and Thompson-Okanagan plateaus.	*SBSdk SBSdw1 SBSdw2 SBSdw3 SBSmc1 SBSmc2 SBSmc3 SBSmh SBSmk1 SBSmk2 SBSwk3 SBPSdc SBPSmc SBPSmk SBPSxc IDFdk3 IDFdk4 IDFdm2 MSxk MSxv*
SM	Subalpine Meadow	Typically a high elevation meadow community, dominated by moisture-loving herbaceous species, found on wetter sites in the subalpine forested areas. This unit occurs throughout the province at elevations ranging between 1000 and 1600 m in the north and 1600 and 2000 m in the south. It occurs in the Vancouver Island and Queen Charlotte Islands Ranges, Coast Mountains, Southern Interior Mountains, and Northern Boreal Mountains, as well as many of the high elevation plateaus found in the province.	*ESSFdc ESSFdk ESSFmc ESSFmk ESSFmm1 ESSFmv3 ESSFmv4 ESSFmw ESSFvc ESSFwc ESSFwk1 ESSFwk2 ESSFwm ESSFwv ESSFxc ESSFxv MHmm1 MHmm2 MHwh1 SWBdk SWBmk*
SP	Slow Perennial Stream	Typically a freshwater riverine habitat contained within a channel that has continuously slow-moving water, is bounded by banks or upland habitat, and has a low gradient; may include channels that form a connecting link between two bodies of standing water. Distributed throughout the province with a larger proportion of slow-moving streams found at lower altitudes where the gradient of the stream is reduced.	

Code	Name[1]	Description	BEC units
SR	Sitka Spruce – Black Cottonwood Riparian	Typically a dense coniferous forest with fern- or shrub-dominated understories, which may progress through plant communities with red alder, black cottonwood, or bigleaf maple to a coniferous mixture of Sitka spruce and western hemlock; found on or in association with fluvial sites. Occurs extensively throughout valley bottoms of the Coast and Mountains ecoprovince, ranging in elevation between sea level and 1000 m.	*CDFmm CWHdm* *CWHmm1* *CWHds1* *CWHds2* *CWHvm1* *CWHms1* *CWHms2* *CWHxm CWHvh1* *CWHvh2* *CWHwh1* *CWHwm* *CWHws1* *CWHws2 ICHvc* *CDFmm CWHdm* *CWHds1 CWHds2* *CWHmm1* *CWHms1* *CWHms2* *CWHvh1 CWHvh2* *CWHvm1* *CWHvm2* *CWHwh1* *CWHwm* *CWHws1* *CWHws2* *CWHxm ICHmc1* *ICHmc2 ICHvc* *ICHwc*
SS	Big Sagebrush Shrub/Grassland	Typically an open to dense, dry shrubland, dominated by drought-tolerant shrubs and perennial grasses, and generally lacking trees. This unit occurs extensively throughout the lower to middle elevations of the Southern Interior and southern portion of the Fraser Plateau; including the Fraser River, Thompson and Okanagan basins, as well as the valleys around the Fraser River in the Pavillion Ranges, Nicola River, and the Similkameen River. More isolated ecosystems are also found in the Granby and Kettle River valleys of the Southern Okanagan Highland. Elevation ranges from 250 to 1300 m with a sagebrush variety change in the higher elevation subzone (MSxk: 1450 to 1650 m).	*BGxh1 BGxh2* *BGxh3 BGxw1* *BGxw2 ESSFxc* *MSxk IDFdk1* *IDFdm1 IDFxh1* *IDFxh2 PPxh1* *PPxh2*
ST	Subtidal Marine	Typically a habitat that consists of open ocean overlying the continental shelf with salinities in excess of 18 ppt and a substrate that is continuously submerged. This unit occurs adjacent to the intertidal shores of all coastal islands and the mainland, including major inlets, fjords, bays, and the open ocean.	*CDFmm CWHdm* *CWHmm1* *CWHms2* *CWHvh1 CWHvh2* *CWHvm1* *CWHwh1* *CWHwm* *CWHws1* *CWHxm1* *CWHxm2*

Code	Name[1]	Description	BEC units
SU	Subalpine Shrub/Grassland	Typically high elevation, northern habitat, characterized by dense shrubs and bunchgrasses, both inter-mixed and occasionally dominated by scrub birch, willows, and Altai fescue. Generally limited to the high elevation areas of the Northern Boreal Mountains and portions of the Omineca and Central Canadian Rocky Mountains. Elevational limits range between 1000 and 1600 m.	*SWBmk SWBun*
SW	Shrub Swamp	A swamp wetland class that typically is a tall shrub wetland, characterized by willows, a sparse cover of spruce and sedges, usually found along stream channels and composed of a mixture of mineral and organic material. Occurs at lower to middle elevations, in a limited extent along creeks and rivers throughout the province.	
TA	Talus	Typically sparsely vegetated, rubbly or blocky colluvial areas, at the base of rock outcroppings, cliffs, or escarpments. Found throughout the province in non-alpine areas, usually on steep slopes below rock outcrops or escarpments. The weathered bedrock sheds blocks of rubble, which accumulate in draws and across the base of steep slopes and cliffs.	
TB	Trembling Aspen – Balsam Poplar	Typically an open, deciduous subalpine forest found on warm aspects, often in association with shrub/grasslands. This important habitat occurs on steep, warm aspects in the Spruce–Willow–Birch biogeoclimatic zone. This unit is limited to elevations ranging between 1050 and 1500 m. It occurs throughout the subalpine areas of the Northern Boreal Mountains; small patches are also present in the Northern Omineca and Central Canadian Rocky mountains, as well as on the Muskwa Plateau.	*SWB*
TC	Transportation Corridor	Typically a linear-shaped land area dedicated to some form of above-ground system for carrying products from one point to another, including roads and railways. Commonly occurs in low to middle elevation biogeoclimatic units throughout the southern half of the province. In more northerly locations they are not as widespread. Transportation corridors tend to be associated with communities, linking one community to another and to resource-related activities.	
TF	Tamarack Wetland	A fen wetland class that typically is an open forested wetland, dominated by tamarack, scrub birch, sedges, and moss. Found between 300 and 1100 m elevation throughout the Boreal and Taiga Plains, as well as the Liard Basin.	*BWBSdk* *BWBSmw1* *BWBSmw2*
TR	Transmission Corridor	Typically a linear-shaped land area dedicated to some form of above or below ground system for carrying products from one point to another, including transmission lines and pipeline. Commonly occurs in low to mid-elevation biogeoclimatic units throughout the southern half of the province. In more northerly locations they are not as widespread in occurrence. Transmission corridors tend to be concentrated around hydroelectric systems.	

Code	Name[1]	Description	BEC units
UR	Urban	Typically a mixture of human-influenced habitats that includes residential and urban areas, but excludes major agricultural lands. Urban development is not limited to specific regions or particular physical environments. However, most urban centres are situated at low elevations and near the coast, large rivers, or lakes.	
UV	Unvegetated	Typically non-alpine, unvegetated areas consisting of exposed soils and excluding unvegetated bedrock sites. Typically the total cover of vegetation, including trees, shrubs, herbs, and lichens, is less than 5% of the total surface area. This limited habitat occurs as a result of natural erosion, as well as human activities. Some typical sources of exposed soils include cutbanks along watercourses and roads, beaches, gravel pits, landings for sorting and loading logs, glacial moraines, mudflats in association with dried up lakes and ponds, and steep slopes where mudslides and debris torrents commonly occur.	
WB	Whitebark Pine Subalpine	Typically a subalpine habitat of open, whitebark pine forests, inter-mixed with lush bunchgrasses, other perennial grasses, and forbs, on droughty sites. Limited to south-facing slopes above the Engelmann Spruce – Subalpine Fir (ESSF) zone and below the Alpine Tundra (AT) zone, east of the leeward Coast Mountains into the Rocky Mountains. Occurs between 1650 and 2100 m elevation in more southerly areas and between 1000 and 1800 m in more northerly locations. Note, there is considerable range in the upper and lower elevational limits due to climatic variability and differing topography.	*ESSFdk ESSFdv ESSFmk ESSFxv*
WG	Hybrid White Spruce Bog Forest	A bog wetland class that is typically a sparse to open, treed organic wetland, composed of hybrid white spruce, with minor amounts of lodgepole pine and moss-dominated understorey. Occurs throughout the interior, east of the Coast Mountains; including the sub-boreal, central and southern interior of the province and into the Southern Interior Mountains. Elevational limits range between 400 and 1450 m. More northerly locations may occur at lower elevations while more southerly locations may occur at higher elevations.	*BWBS IDF MSdk MSxv SBPS SBS ICH*
WL	Wetland	Used for any wetland habitat class that cannot be recognized at small mapping scales.	
WP	Subalpine Fir – Mountain Hemlock Wet Parkland	Typically a high elevation mosaic of tree clumps and subalpine meadows or tundra, occurring above the closed forest and below the alpine. This unit occurs above the Engelmann Spruce – Subalpine Fir (ESSF) zone in the eastern Kitimat Ranges, south/central Hazelton Mountains, southeast Boundary Ranges, and northwest Skeena Mountains; elevation is approximately 1800 m. There is also a limited amount of this unit found on the leeward side of the Pacific Ranges, as well as in the western Monashee Mountains, at approximately 1675 m. Note, there is considerable range in the upper and lower elevational limits due to climatic variability and differing topography.	*ESSFmk ESSFmw ESSFvc ESSFwv*

Code	Name[1]	Description	BEC units
WR	Hybrid White Spruce – Black Cottonwood Riparian	Typically a dense deciduous, mixed or coniferous forest with shrub-dominated understories, found on, or in association with fluvial sites; includes plant communities that succeed slowly through black cottonwood to potential hybrid white spruce climax. Occurs throughout the interior, east of the Coast Mountains; including the sub-boreal, central, and southern interior and into the Southern Interior Mountains. Elevational limits range between 400 and 1450 m. More northerly locations may occur at lower elevations while more southerly locations may occur at higher elevations.	*ICHdk ICHmc1 ICHmc2 ICHwk1 IDFdk1 IDFdk2 IDFdk3 IDFdk4 IDFdm1 IDFdm2 IDFxm IDFxw IDFxh1 IDFxh2 SBPSdc SBPSmc SBPSmk SBPSxc SBSdh1 SBSdh2 SBSdk SBSdw1 SBSdw2 SBSmc1 SBSmc2 SBSmc3 SBSmh SBSmk1 SBSmk2 SBSmm SBSmw SBSvk SBSwk1 SBSwk2 SBSwk3 MSdk MSxv PPdh2 PPxh1*
YB	Yellow-cedar Bog Forest	Typically an open forest with shrubby yellow-cedar, mountain hemlock, and western hemlock; found on poorly drained sites. This unit is found on the western slopes of the Coast Mountains, north of the Fraser River through to the Alaskan border and throughout the Hecate Lowlands. It also occurs on the islands along the coast, including the Queen Charlotte Islands and Vancouver Island. It is restricted to the windward portion of southern Vancouver Island and expands to cover all of northern Vancouver Island, north of Kelsey Bay. Typically, the elevational limits of this unit range between sea level and approximately 1800 m.	*CWHmm2 CWHvh1 CWHvh2 CWHvm1 CWHvm2 CWHwh1 CWHwh2 MHmm1 MHmm2 MHwh*
YM	Yellow-cedar – Mountain Hemlock Forest	Typically an open scrubby forest with a well-developed understorey; mountain hemlock and yellow-cedar are the dominant climax species. Occurs at high elevations on the Queen Charlotte Islands and in hypermaritime areas of the coast, including major coastal islands north of Smith Inlet; typically found at elevations ranging from 500 to 1100 m.	*MHmm1 MHmm2 MHwh*
YS	Yellow-cedar Skunk Cabbage Swamp Forest	Typically an open forested wetland of yellow-cedar with an understorey of skunk cabbage and sparse shrubs found on poorly drained mineral sites. Occurs at higher elevations, ranging between 500 and 1600 m, on the Queen Charlotte Islands, Vancouver Island, and the Mainland Coast, expanding east into the Coast Mountains and north to the Alaskan border.	*MHmm1 MHmm2 MHwh*

Appendix 5. Structural stages and codes[1]

From *Standards for Terrestrial Ecosystems Mapping in British Columbia*. 1998. Ecosystems Working Group of the Terrestrial Ecosystems Task Force, Resources Inventory Committee.

Structural stage	Description
	Post-disturbance stages or environmentally induced structural development
1 Sparse/bryoid[a]	Initial stages of primary and secondary succession; bryophytes and lichens often dominant, can be up to 100%; time since disturbance <20 years for normal forest succession, may be prolonged (50–100+ years) where there is little or no soil development (bedrock, boulder fields); total shrub and herb cover <20%; total tree layer cover <10%.
Substages	
1a Sparse[a]	<10% vegetation cover
1b Bryoid[a]	Bryophyte- and lichen-dominated communities (>½ of total vegetation cover).
	Stand initiation stages or environmentally induced structural development
2 Herb[a]	Early successional stage or herbaceous communities maintained by environmental conditions or disturbance (e.g., snow fields, avalanche tracks, wetlands, grasslands, **flooding**, intensive grazing, intense fire damage); dominated by herbs (forbs, graminoids, ferns); some invading or residual shrubs and trees may be present; tree layer cover <10%, shrub layer cover <or equal to 20% or <1/3 of total cover, herb-layer cover >20%, or >or equal to 1/3 of total cover; time since disturbance <20 years for normal forest succession; many herbaceous communities are perpetually maintained in this stage.
Substages	
2a Forb -dominated[a]	Herbaceous communities dominated (>½ of the total herb cover) by non-graminoid herbs, including ferns.
2b Graminoid -dominated[a]	Herbaceous communities dominated (>½ of the total herb cover) by grasses, sedges, reeds, and rushes.
2c Aquatic[a]	Herbaceous communities dominated (>½ of the total herb cover) by floating or submerged aquatic plants; does not include sedges growing in marshes with standing water (which are classed as 2b).
2d Dwarf shrub[a]	Communities dominated (>½ of the total herb cover) by dwarf woody species such as *Phyllodoce empetriformis, Cassiope mertensiana, Cassiope tetragona, Arctostaphylos arctica, Salix reticulata,* and *Rhododendron lapponicum.* (See list of dwarf shrubs assigned to the herb layer in the *Field Manual for Describing Terrestrial Ecosystems.*)
3 Shrub/Herb[b]	Early successional stage or shrub communities maintained by environmental conditions or disturbance (e.g., snow fields, avalanche tracks, wetlands, grasslands, **flooding**, intensive grazing, intense fire damage); dominated by shrubby vegetation; seedlings and advance regeneration may be abundant; tree layer cover <10%, shrub layer cover >20% or >or equal to 1/3 of total cover.
Substages	
3a Low shrub[b]	Communities dominated by shrub layer vegetation <2 m tall; may be perpetuated indefinitely by environmental conditions or repeated disturbance; seedlings and advance regeneration may be abundant; time since disturbance <20 years for normal forest succession.

---

[1] In the assessment of structural stage, structural features and age criteria should be considered together. Broadleaf stands will generally be younger than coniferous stands belonging to the same structural stage.

Structural stage	Description
3b Tall shrub[b]	Communities dominated by shrub layer vegetation that are 2–10 m tall; may be perpetuated indefinitely by environmental conditions or repeated disturbance; seedlings and advance regeneration may be abundant; time since disturbance less than 40 years for normal forest succession.
	Stem exclusion stages
4 Pole/Sapling[c]	Trees >10 m tall, typically densely stocked, have overtopped shrub and herb layers; younger stands are vigorous (usually >10–15 years old); older stagnated stands (up to 100 years old) are also included; self-thinning and vertical structure not yet evident in the canopy – this often occurs by age 30 in vigorous broadleaf stands, which are generally younger than coniferous stands at the same structural stage; time since disturbance is usually <40 years for normal forest succession; up to 100+ years for dense (5000–15 000+ stems per hectare) stagnant stands.
5 Young Forest[c]	Self-thinning has become evident and the forest canopy has begun differentiation into distinct layers (dominant, main canopy, and overtopped); vigorous growth and a more open stand than in the pole/sapling stage; time since disturbance is generally 40–80 years but may begin as early as age 30, depending on tree species and ecological conditions.
	Understorey reinitiation stage
6 Mature Forest[c]	Trees established after the last disturbance have matured; a second cycle of shade tolerant trees may have become established; understories become well developed as the canopy opens up; time since disturbance is generally 80–140 years for biogeoclimatic group A[d] and 80–250 years for group B.[e]
	Old-growth stage
7 Old Forest[c]	Old, structurally complex stands composed mainly of shade-tolerant and regenerating tree species, although older seral and long-lived trees from a disturbance such as fire may still dominate the upper canopy; snags and **coarse woody debris** in all stages of decomposition typical, as are patchy understories; understories may include tree species uncommon in the canopy, due to inherent limitations of these species under the given conditions; time since disturbance generally >140 years for biogeoclimatic group A[d] and >250 years for group B.[e]

---

[a] Substages 1a, 1b, and 2a–d should be used if photo interpretation is possible, otherwise, stages 1 and 2 should be used.

[b] Substages 3a and 3b may, for example, include very old krummholz less than 2 m tall and very old, low productivity stands (e.g., bog woodlands) <10 m tall, respectively. Stage 3, without additional substages, should be used for regenerating forest communities that are herb- or shrub-dominated, including shrub layers consisting of only 10–20% tree species, and undergoing normal succession toward climax forest (e.g., recent cut-over areas or burned areas).

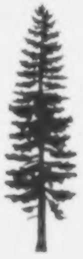
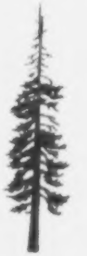
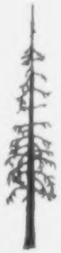
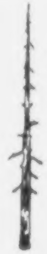
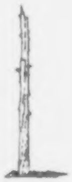
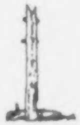
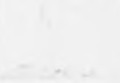
[c] Structural stages 4–7 will typically be estimated from a combination of attributes based on forest inventory maps and aerial photography. In addition to structural stage designation, actual age for forested units can be estimated and included as an attribute in the database, if required.

[d] Biogeoclimatic Group A includes BWBSdk, BWBSmw, BWBSwk, BWBSvk, ESSFdc, ESSFdk, ESSFdv, ESSFxc, ICHdk, ICHdw, ICHmk1, ICHmk2, ICHmw3, MS (all subzones), SBPS (all subzones), SBSdh, SBSdk, SBSdw, SBSmc, SBSmh, SBSmk, SBSmm, SBSmw, SBSwk1 (on plateau), and SBSwk3.

[e] Biogeoclimatic Group B includes all other biogeoclimatic units (see Appendix C).

Appendix 6. Wildlife tree classification for coniferous trees

From: *Vegetation Resource Inventory Ground Sampling Procedures*. 2002. B.C. Ministry of Sustainable Resource Management, Terrestrial Information Branch for the Resource Inventory Committee. See http://srmwww.gov.bc.ca/tib/veginv/publications.htm.

	LIVE		DEAD					DEAD FALLEN	
			Hard			Spongy	Soft		
Tree class	1	2	3	4	5	6	7	8	9
						approx. 2/3 original height 	approx. 1/2 original height 	approx. 1/3 original height 	
Description	**Live/healthy**: no decay; tree has valuable habitat characteristics such as large, clustered or gnarled branches, or horizontal, thickly moss-covered branches.*	**Live/unhealthy**: internal decay or growth deformities (including insect damage, broken tops); dying tree.*	**Dead**: needles or twigs may be present; roots sound.	**Dead**: no needles/twigs; 50% of branches lost; loose bark; top usually broken; roots stable.	**Dead**: most branches/bark absent; some internal decay; roots of larger trees stable.	**Dead**: no branches or bark; sapwood/heartwood sloughing from upper bole; decay more advanced; lateral roots of larger trees softening; smaller ones unstable.	**Dead**: extensive internal decay; outer shell may be hard; lateral roots completely decomposed; hollow or nearly hollow shells.		**Debris**: downed trees or stumps.
Uses and users	Nesting (e.g., Bald Eagle, Great Blue Heron colonies, Marbled Murrelet); feeding; roosting; perching.	Nesting/roosting[1] —strong PCEs[2] (woodpeckers); SCUs[3]; large-limb and platform nests (Ospreys); insect feeders.	Nesting/roosting—strong PCEs; SCUs; bats.	Nesting/roosting—PCEs; SCUs; insect feeders.	Nesting/roosting—weak PCEs (nuthatches, chickadees); SCUs; bats; insect feeders.	Weaker PCEs; SCUs; insect feeders; salamanders; small mammals; hunting perches.	Insect feeders; salamanders; small mammals; hunting perches; occasionally used by weak cavity excavators such as chickadees.		Insect feeders; salamanders; small mammals; drumming logs for grouse; flicker foraging; nutrient source.

[1] Large witches' brooms provide nesting/denning habitat for some species (e.g., fisher, squirrels).

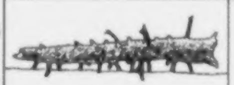
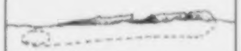
[2] PCE = primary cavity excavator

[3] SCU = secondary cavity user

* This classification system does not recognize root disease trees specifically. Such trees become unstable at or before death.

Appendix 7. Coarse woody debris classification

Adapted from: *Vegetation Resource Inventory Ground Sampling Procedures.* 2002. B.C. Ministry of Sustainable Resource Management, Terrestrial Information Branch for the Resource Inventory Committee. See http://srmwww.gov.bc.ca/risc/pubs/teveg/vri%20ground%20sampling2k2/vrigro%7e1.pdf.

	Decay Class				
Characteristics of fallen	 **Log class 1**	**Log class 2**	**Log class 3**	 **Log class 4**	**Log class 5**
Bark	intact	intact	trace	absent	absent
Twigs	present	absent	absent	absent	absent
Texture	intact	intact to partly soft	hard, large pieces	small, soft blocky pieces	soft and powdery
Shape	round	round	round	round to oval	oval
Colour of wood	original colour	original colour	original colour to faded	light brown to reddish brown	red brown to dark brown
Portion of tree on ground	tree elevated on support points	tree elevated on support points but sagging slightly	tree sagging near ground	all of tree on ground	all of tree on ground
Invading roots	none	none	in sapwood	in heartwood	in heartwood

Appendix 8. Scientific names of commonly referred to tree and wildlife species

English name	Scientific name	Code
Alaska paper birch	*Betula neoalaskana*	Ea
alpine larch	*Larix lyallii*	La
amabilis fir	*Abies amabilis*	Ba
balsam poplar	*Populus balsamifera* ssp. *balsamifera*	Acb
bigleaf maple	*Acer macrophyllum*	Mb
black cottonwood	*Populus balsamifera* ssp. *trichocarpa*	Act
Douglas-fir	*Pseudotsuga menziesii*	Fd
Engelmann spruce	*Picea engelmannii*	Se
Garry oak	*Quercus garryana*	Qg
grand fir	*Abies grandis*	Bg
jack pine	*Pinus banksiana*	Pj
limber pine	*Pinus flexilis*	Pf
lodgepole pine	*Pinus contorta*	Pl
mountain hemlock	*Tsuga mertensiana*	Hm
Pacific dogwood	*Cornus nuttallii*	Gp
paper birch	*Betula papyrifera*	Ep
ponderosa pine	*Pinus ponderosa*	Py
poplar	*Populus balsamifera*	Ac
red alder	*Alnus rubra*	Dr
Sitka spruce	*Picea sitchensis*	Ss
subalpine fir	*Abies lasiocarpa*	Bl
tamarack	*Larix laricina*	Lt
trembling aspen	*Populus tremuloides*	At
vine maple	*Acer circinatum*	Mv
water birch	*Betula occidentalis*	Ew
western hemlock	*Tsuga heterophylla*	Hw
western larch	*Larix occidentalis*	Lw
western redcedar	*Thuja plicata*	Cw
western white pine	*Pinus monticola*	Pw
white spruce	*Picea glauca*	Sw
whitebark pine	*Pinus albicaulis*	Pa
yellow-cedar	*Chamaecyparis nootkatensis*	Yc
Pileated Woodpecker	*Dryocopus pileatus*	B-PIWO
Northern Flicker	*Colaptes auratus*	B-NOFL
Hairy Woodpecker	*Picoides villosus*	B-HAWO
Red-breasted Sapsucker	*Sphyrapicus rubber*	B-RBSA

Appendix 9. NatureServe status

NatureServe is a non-profit and independent organization that provides information on the conservation status of the world's plants, animals, and ecological communities. Formed in 1999 by the Nature Conservancy and the Natural Heritage Network, NatureServe uses standard criteria developed by NatureServe, the Nature Conservancy, and the Natural Heritage Network to assign conservation ranks. The ranking system is unique in three key respects: it is based on objective biological criteria; it is applicable at multiple geographic levels; and it includes ranks not just for species but for ecological communities. For more information on NatureServe, its methods, and its ranks, visit the NatureServe Web page at http://www.natureserve.org/explorer/aboutd.htm.

In short, each element is ranked at three geographic levels: global (G), national (N), and subnational (S). The global rank is based on the status of the element throughout its entire range whereas the subnational rank is based solely on its status within a state, province, or territory. Each element is assigned a rank between one and five unless considered extirpated, extinct, historical, or unranked (see descriptions below). The rank is based on the number of extant occurrences of the element, but other factors such as abundance, range, protection, and threats are also considered if the information is available. For information on ranking in British Columbia, visit http://wlapwww.gov.bc.ca/wld/documents/ranking.pdf.

Code	Rank	Definition
1	Critically Imperiled	*Extremely rare or some factor(s) makes it especially susceptible to extirpation or extinction. Typically ≤5 existing occurrences or very few remaining individuals.*
2	Imperiled	*Rare or some factor(s) makes it very susceptible to extirpation or extinction. Typically 6 to 20 existing occurrences or few remaining individuals.*
3	Vulnerable	*Rare and local, found only in a restricted range (even if abundant at some locations), or because of some other factor(s) making it susceptible to extirpation or extinction. Typically 21 to 100 existing occurrences.*
4	Apparently Secure	*Uncommon but not rare, and usually widespread in the province. Possible cause for long-term concern. Typically >100 existing occurrences.*
5	Secure	*Common to very common, typically widespread and abundant, and not susceptible to extirpation or extinction under present conditions.*
X	Extirpated or extinct	*Not located despite intensive searches and no expectation that it will be rediscovered; presumed to be extirpated or extinct.*
H	Historical	*Not located in the last 50 years, but some expectation that it may be rediscovered.*
?	Unranked	*Rank not yet assessed.*
U	Unrankable	*Due to current lack of available information.*

In addition to the above ranks, the following ranking modifiers are defined below.

B	Associated rank refers to breeding occurrences of mobile animals
E	An exotic species or species introduced by humans to the province
N	Associated rank refers to non-breeding occurrences of mobile animals
Q	Taxonomic status is unclear or is in question
R	Reported from the province, but without persuasive documentation for either accepting or rejecting the report
T	A rank associated with a subspecies or variety
Z	Occurs in the province but as a diffuse, usually moving population; difficult or impossible to map static occurrences

Appendix 10. Determining wildlife tree dbh recommendations for cavity-nesters

Resource managers often apply minimum size recommendations (e.g., wildlife tree dbh) to achieve wildlife conservation objectives. The use of minimum dbh sizes for retention of wildlife trees may not be the best management practice for cavity-nesters. Larger diameter wildlife trees provide important features including larger diameter cavities and thicker insulation around the nest cavity. An alternative approach to minimum sizes is to use the mean plus one standard deviation. Since information is not always available for a specific species of cavity-nester, it may be possible to use information from a primary cavity-nester to approximate the characteristics of the trees that will be selected by the secondary cavity-nester. Both the Pileated Woodpecker (*Dryocopus pileatus*) and Northern Flicker (*Colaptes auratus*) are primary cavity nesters and provide nesting and roosting cavities for many secondary cavity users. A summary of the nesting requirements of these two species is provided in Tables 10-1 and 10-2.

Table 10-1. Characteristics (mean ± SD) (cm) of Pileated Woodpecker nest trees in coastal and interior ecosystems

Location	Forest type	N	Tree dbh (cm)	Tree height (m)	Nest height (m)	Citation
Coastal ecosystems						
Western Washington	Western hemlock, Pacific silver fir	27	100.5	39.7	35.2	Aubrey and Raley (1996)
Oregon Coast Ranges	Western hemlock	15	68.9 ± 25	26.5 ± 16	19.9 ± 11	Mellen (1987)
Oregon Coast Ranges	Western hemlock	6	67.0 ± 20.3	26.5 ± 14.7	16.7 ± 5.4	Nelson (1988)
South Cascades	Mixed conifer to Douglas-fir	2	88.0 ± 19.8	40.0 ± 4.2	19.0 ± 4.2	Lundquist (1988)
Southeast Vancouver Island	CWHxm, CDF	7	82 ± 42	22 ± 13.8	17.4 ± 9.3	Hartwig (1999)
North Vancouver Island	CWHxm, CWHvm, MHmm	2	84.2 ± 17.5	36.7 ± 9.1	16.1 ± 3.4	Deal and Setterington (2000)
Interior ecosystems						
Blue Mountains, Oregon	Coniferous	105	84	28	15	Bull (1987)
Okanogan National Forest	Coniferous	6	84.2 ± 17.5	36.7 ± 9.1	16.1 ± 3.4	Madsen (1985)
Northern Montana	Coniferous	89	73.4 ± 1.9	29.0 ± 1.0	15.9 ± 0.6	McClelland and McClelland (1999)
South-central B.C.	Deciduous (IDF)	20	40.5 ± 7.1	19.2 ± 6.3	9.2 ± 1.8	Harestad and Keisker (1989)
West-central Alberta and northern B.C.	Deciduous	98	44.0			Bonar (1997)

Table 10-2. Characteristics (mean ± SD) of Northern Flicker nest trees in coastal and interior ecosystems

Location	Forest type	N	Tree dbh (cm)	Tree height (m)	Nest height (m)	Citation
Coastal ecosystems						
Northern Vancouver Island	CWHxm, CWHvm, MHmm	85	73.1 ± 3.4	22.6 ± 1.1		Deal and Setterington (2000)
Oregon Coast Ranges	Western hemlock	9	95.8 ± 30.0	38.6 ± 9.6	35.6 ± 10.8	Nelson (1988)
South Cascades	Mixed conifer to Douglas-fir	3	127.7 ± 38.5	46.3 ± 15.0	38.7 ± 20.6	Lundquist (1988)
Interior ecosystems						
Okanogan National Forest	Coniferous	16	70.4 ± 27.2	20.8 ± 11.9	14.3 ± 9.7	Madsen (1985)
South-central B.C.	Deciduous	17	31.9 ± 9.9	14.7 ± 7.8	5.7 ± 3.7	Harestad and Keisker (1989)
Riske Creek, B.C.	Deciduous	159	33.87 ± 10.34		3.32 ± 2.82	Wiebe (2001)

Many secondary cavity-nesters depend on more than one primary cavity-excavator for suitable cavities. Thus several data sets can be combined by using a weighted mean, which will give proportional weight to studies according to their sample sizes. This method may be used to calculate an optimum recommended dbh tree size for retention in coastal and interior ecosystems (see Table 10-3 for examples or the Pileated Woodpecker and Northern Flicker).

1. Derive recommended mean from mean values from studies on appropriate species of cavity-nesters.
2. Standardize data from studies by converting standard errors to standard deviation. Standard deviation = standard error * $\sqrt{n}$ (Zar 1996).
3. Include data from generally similar ecosystems (i.e., northwestern U.S. and southwestern Canada and separate interior from coastal studies when appropriate).
4. Give more weight to studies that have larger sample sizes by using a weighted mean. The recommended mean is a weighted mean that is being used here to combine the means from two or more studies while adjusting for differences between subgroup frequencies (weighted mean = $\sum x_i * n_i / \sum n_i$). A pooled standard deviation can be calculated from the studies. Pooled SD = $\sqrt{[\sum [SD_i^2 (n_i - 1)] / [\sum n_i - G]}$ where G is the number of groups or studies (R. Davidson, statistics professor, Univ. Victoria, BC, retired).

Table 10-3. Recommendations for optimum size dbh (mean + 1SD) (cm) for Northern Flicker and Pileated Woodpecker in British Columbia based on weighted mean and pooled standard deviation

Location	Northern Flicker		Pileated Woodpecker	
	Coniferous	Deciduous	Coniferous	Deciduous
Interior ecosystems	70–98[a] or larger	34–44 or larger	74–80 or larger	41–48 or larger
Coastal ecosystems	77–88 or larger		74–102 or larger	

[a] After Madsen (1985) only.

References Cited

Aubrey, K.B and C.M. Raley. 1996. Ecology of Pileated Woodpecker in managed landscapes on the Olympic Peninsula: Progress rep. *In* Wildlife ecology team 1995 annual report. U.S. Dep. Agric. For. Serv., Olympia, Wash., pp. 61–64. Unpublished.

Bonar, R.L. 1997. Pileated Woodpecker habitat ecology in boreal forests: 1996-1997 Progress Report. Weldwood of Canada Ltd., Hinton, Alta. 43 p.

Bull, E.L. 1987. Ecology of the Pileated Woodpecker in north-eastern Oregon. J. Wildl. Manage. 51:472–481.

Deal, J.D. and M. Setterington. 2000. Woodpecker nest habitat in the Nimpkish Valley, Northern Vancouver Island. Unpubl. rep. prepared for Canfor, Woss, B.C. 67 p.

Harestad, A.S. and D.G. Keisker. 1989. Nest tree use by primary cavity-nesting birds in south-central British Columbia. Can. J. Zool. 67:1067–1073.

Hartwig, C.L. 1999. Effect of forest age, structural elements, and prey density on the relative abundance of Pileated Woodpecker on southeastern Vancouver Island. M.Sc. thesis. Univ. Victoria, Victoria, B.C. 162 p.

Lundquist, R.W. 1988. Habitat use by cavity-nesting birds in the southern Washington Cascades. M.Sc. thesis. Univ. Wash., Seattle, Wash. 112 p.

Madsen, S.J. 1985. Habitat use by cavity-nesting birds in the Okanogan National Forest, Washington. M.Sc. thesis. Univ. Wash., Seattle, Wash. 113 p.

McClelland, B.R. and P.T. McClelland. 1999. Pileated Woodpecker nest and roost trees in Montana: links with old-growth and forest "health." Wildl. Soc. Bull. 27:846–857.

Mellen, T.K. 1987. Home range and habitat use of Pileated Woodpeckers, western Oregon. M.Sc. thesis. Oregon State Univ., Corvallis, Oreg. 75 p.

Nelson, S.K. 1988. Habitat use and densities of cavity-nesting birds in the Oregon Coast Ranges. M.Sc. thesis. Oregon State Univ., Corvallis, Oreg. 142 p.

Wiebe, K.L. 2001. Microclimate of tree cavity nests: is it important for reproductive success in Northern Flickers? Auk 118(2):412–421.

Zar, J.H. 1996. Biostatistical analysis. Prentice Hall, Upper Saddle River, N.J. 662 p.

Appendix 11. Coast region Identified Wildlife forest district tables

Campbell River Forest District

Common Name	CPR	JOS	LIM	NAL	NIM	NWL	OUF	SOG	WIM
Amphibians									
Coastal Tailed Frog	X						X		
Red-legged Frog			X	X	X	X	P		X
Birds									
Great Blue Heron	X		X	X	X	X	X	X	X
Long-billed Curlew			I	I					I
Marbled Murrelet	X	X	X	X	X	X	X	X	X
Queen Charlotte Goshawk			X	X	X	X	P	X	X
Short-eared Owl			X	X	X				X
Mammals									
Keen's Long-eared Myotis	X		X	X	X	X	X		X
Grizzly Bear	X						X		
Vancouver Island Marmot			X						
Wolverine	P		P	P	P	P			P

X = Present; T = Introduced; I = Irregular/incidental; P = Possible; H = Historic; * = Extirpated in parts

Chilliwack Forest District

Common Name	EPR	FRL	GEL	HOR	LPR	NWC	SOG	SPR
Amphibians								
Coastal Giant Salamander		X	X			X		X
Coastal Tailed Frog	X	X	X	X	X	X		X
Red-legged Frog	P	X	X			X		X
Birds								
Burrowing Owl		H						
Great Blue Heron	X	X	X		X	X	X	X
Lewis's Woodpecker		H						
Long-billed Curlew		I	I					
Marbled Murrelet	X	X	X			X	X	X
Short-eared Owl		X	X					
Spotted Owl	X	X		X	X	X		X
Yellow-breasted Chat		X						
Mammals								
Badger				X				
Grizzly Bear	*	H	H	X	X	H		*
Keen's Long-eared Myotis		X						X
Pacific Water Shrew	X	X						X
Wolverine	X			X	X	X		X
Plants								
Tall Bugbane	X					X		

X = Present; T = Introduced; I = Irregular/incidental; P = Possible; H = Historic; * = Extirpated in parts

North Coast Forest District

Common Name	HEL	KIR	MEM	NAM	SBR
Amphibians					
Coastal Tailed Frog	X	X		X	X
Birds					
Great Blue Heron	X	X	X	X	X
Marbled Murrelet	X	X	X	X	X
Queen Charlotte Goshawk	P				P
Mammals					
Grizzly Bear	X	X	X	X	X
Keen's Long-eared Myotis		X			X
Wolverine	X	X	X	X	X

X = Present; T = Introduced; I = Irregular/incidental; P = Possible; H = Historic; * = Extirpated in parts

North Island–Central Coast Forest District

Common Name	CCR	CPR	HEL	KIM	KIR	NAU	NEU	NIM	NPR	NWL	OUF	WCR	WIM
Amphibians													
Coastal Tailed Frog		X	X	X	X				X		X		
Red-legged Frog			P					X		X	P		X
Birds													
Great Blue Heron		X	X	X	X	X	X	X	X	X	X		X
Marbled Murrelet		X	X	X	X			X	X	X	X		X
Queen Charlotte Goshawk			P					X		X	P		X
Short-eared Owl	X							X					X
Mammals													
Grizzly Bear	X	X	X	X	X	*	X		X		X	X	
Keen's Long-eared Myotis		X		X	X			X	X	X	X		X
Northern Caribou					X	X	X					X	
Wolverine	P	P		P	P	P	P	P	P	P		P	P

X = Present; T = Introduced; I = Irregular/incidental; P = Possible; H = Historic; * = Extirpated in parts

Queen Charlotte Islands Forest District

Common Name	QCL	SKP	WQC
Birds			
Ancient Murrelet		X	X
Great Blue Heron	X	X	X
Marbled Murrelet	X	X	X
Queen Charlotte Goshawk	X	X	X
Mammals			
Keen's Long-eared Myotis	X	X	X

X = Present; T = Introduced; I = Irregular/incidental; P = Possible; H = Historic; * = Extirpated in parts

South Island Forest District

Common Name	LIM	NAL	SGI	SOG	WIM
Amphibians					
Northern Leopard Frog		T			
Red-legged Frog	X	X	X		X
Birds					
Great Blue Heron	X	X	X	X	X
Lewis's Woodpecker	H	H			
Long-billed Curlew	I	I			I
Queen Charlotte Goshawk	X	X	X	X	X
Marbled Murrelet	X	X	X	X	X
Short-eared Owl	X	X			X
Mammals					
Keen's Long-eared Myotis	X	X			X
Vancouver Island Marmot	X				
Plants					
Scouler's Corydalis	X				X

X = Present; T = Introduced; I = Irregular/incidental; P = Possible; H = Historic; * = Extirpated in parts

Squamish Forest District

Common Name	CPR	EPR	LPR	SCR	SOG	SPR
Amphibians						
Coastal Tailed Frog	X	X	X	X		X
Red-legged Frog		P				X
Birds						
Great Blue Heron	X	X	X	X	X	X
Marbled Murrelet	X	X			X	X
Spotted Owl		X	X			X
Mammals						
Grizzly Bear	X	*	X	X		*
Pacific Water Shrew		X				X
Keen's Long-eared Myotis	X					X
Wolverine	X	X	X	X		X

X = Present; T = Introduced; I = Irregular/incidental; P = Possible; H = Historic; * = Extirpated in parts

Sunshine Coast Forest District

Common Name	CCR	CPR	EPR	GEL	OUF	SCR	SOG	SPR
Fish								
Vananda Creek Sticklebacks							X	
Amphibians								
Coastal Tailed Frog		X	X	X	X	X		X
Red-legged Frog			P	X	P			X
Birds								
Great Blue Heron		X	X	X	X	X	X	X
Marbled Murrelet		X	X	X	X		X	X
Queen Charlotte Goshawk				P	P		X	
Mammals								
Grizzly Bear	X	X	*	H	X	X		*
Keen's Long-eared Myotis		X			X			X
Wolverine	X	X	X		X	X		X

X = Present; T = Introduced; I = Irregular/incidental; P = Possible; H = Historic; * = Extirpated in parts

Appendix 11. Northern Interior region Identified Wildlife forest district tables

Fort Nelson Forest District

Common Name	CAR	CLH	EMR	ETP	FNL	HYH	KEM	LIP	MAU	MUF	MUP	PEP	SBP	SIU	TLP
Birds															
Short-eared Owl					X					X	X				X
Mammals															
Boreal Caribou		X		X	X				X		X	X			X
Grizzly Bear	X	*	X	X	X	X	X	X	X	X	X	X	X	X	X
Northern Caribou	X		X			X	X	X		X	X		X		
Wolverine	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X

X = Present; T = Introduced; I = Irregular/incidental; P = Possible; H = Historic; * = Extirpated in parts

Fort St. James Forest District

Common Name	BAU	ESM	MAP	NEL	NOM	NSM	SBP	SOM	SSM
Birds									
Long-billed Curlew				P					
Mammals									
Grizzly Bear	X	X	X	X	X	X	X	X	X
Northern Caribou	X	X	X				X	X	
Wolverine	X	X	X	X	X	X	X	X	X

X = Present; T = Introduced; I = Irregular/incidental; P = Possible; H = Historic; * = Extirpated in parts

Kalum Forest District

Common Name	BUR	CRU	ESM	KIM	KIR	MEM	NAB	NAM	NSM	SBR
Amphibians										
Coastal Tailed Frog				X	X			X		X
Birds										
Great Blue Heron				X	X	X	P	X	X	X
Marbled Murrelet		P		X	X	X	X	X		X
Mammals										
Grizzly Bear	X	X	X	X	X	X	X	X	X	X
Wolverine	X	X	X	X	X	X	X	X	X	X

X = Present; T = Introduced; I = Irregular/incidental; P = Possible; H = Historic; * = Extirpated in parts

Mackenzie Forest District

Common Name	BAU	CAR	EMR	ESM	KEM	MAP	MCP	MIR	NEL	NHR	NOM	PAT	PEF	SBP	SOM	WMR
Birds																
Short-eared Owl									P							
Mammals																
Grizzly Bear	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Northern Caribou	X	X	X	X	X	X		X						X	X	X
Wolverine	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X

X = Present; T = Introduced; I = Irregular/incidental; P = Possible; H = Historic; * = Extirpated in parts

Nadina Forest District

Common Name	BAU	BUB	BUR	KIM	KIR	MAP	NAM	NAU	NEU
Mammals									
Grizzly Bear	X	X	X	X	X	X	X	*	X
Northern Caribou	X	X	X		X	X	X	X	X
Wolverine	X	X	X	X	X	X	X	X	X

X = Present; T = Introduced; I = Irregular/incidental; P = Possible; H = Historic; * = Extirpated in parts

Peace Forest District

Common Name	CLH	EMR	FNL	FRR	HAF	HAP	KIP	MIR	MUF	MUP	NHR	PEF	PEL	SHR	WMR
Birds															
Short-eared Owl			X				X		X	X			X		
Mammals															
Boreal Caribou	X		X			X	X			X					
Grizzly Bear	*	X	X	X	X	*	*	X	X	X	X	X	H	X	X
Mountain Caribou											X			X	
Northern Caribou		X		X	X	X	X	X	X	X		X			X
Wolverine	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X

X = Present; T = Introduced; I = Irregular/incidental; P = Possible; H = Historic; * = Extirpated in parts

Prince George Forest District

Common Name	BAU	BOV	CAM	FRR	MCP	NAU	NEL	NHR	NPK	QUL	SHR	UFT
Birds												
Long-billed Curlew							X			X		X
Short-eared Owl							X			X		
Mammals												
Grizzly Bear	X	X	X	X	X	*	X	X	X	*	X	X
Mountain Caribou		X	X						X			X
Northern Caribou	X			X		X						
Wolverine	X	X	X	X	X	X	X	X	X	X	X	X

X = Present; T = Introduced; I = Irregular/incidental; P = Possible; H = Historic; * = Extirpated in parts

Skeena Stikine Forest District

Common Name	ALR	BAU	BUB	BUR	CAR	CBR	CRU	ESM	KEM	KLR	LIP	MAP	MEM	NAB	NAM
Amphibians															
Coastal Tailed Frog															X
Birds															
Marbled Murrelet						X	P						X	X	X
Short-eared Owl															
Mammals															
Grizzly Bear	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
Northern Caribou		X	X	X	X		X	X	X		X	X		X	X
Wolverine	X	X	X	X	X	X	X	X	X	X	X	X	X	X	

Skeena Stikine Forest District (continued)

Common Name	NBR	NSM	SBP	SBR	SSM	STH	STP	TAB	TAH	TEB	TEP	THH	TUR	WHU
Amphibians														
Coastal Tailed Frog				X										
Birds														
Marbled Murrelet	X			X										
Short-eared Owl								X						
Mammals														
Grizzly Bear		X	X	X	X	X	X	X	X	X	X	X	X	X
Northern Caribou			X				X		X	X	X		X	
Wolverine		X	X	X	X	X	X	X	X	X	X	X	X	X

X = Present; T = Introduced; I = Irregular/incidental; P = Possible; H = Historic; * = Extirpated in parts

Vanderhoof Forest District

Common Name	BAU	BUB	NAU	NEL
Birds				
Long-billed Curlew				X
Mammals				
Grizzly Bear	X	X	*	X
Northern Caribou	X	X	X	
Wolverine	X	X	X	X

X = Present; T = Introduced; I = Irregular/incidental; P = Possible; H = Historic; * = Extirpated in parts

Appendix 11. Southern Interior region Identified Wildlife forest district tables

100 Mile House Forest District

Common Name	CAB	CAP	FRB	PAR	QUH	SHH	TRU
Amphibians							
Great Basin Spadefoot	X	P	P	P			
Reptiles							
Great Basin Gopher Snake			X	X			
Birds							
Flammulated Owl	X		X	X			X
Lewis's Woodpecker	P	P	X	X			X
Long-billed Curlew	X		X	X			
Short-eared Owl	X		X				
Yellow-breasted Chat			P				
Mammals							
Badger	X	X	X	X		X	
Fringed Myotis	P		X	P			
Grizzly Bear	H	*	H	*	X	X	X
Mountain Caribou					X	X	
Spotted Bat	X		X	X			
Wolverine	X	X	X	X	X	X	X

X = Present; T = Introduced; I = Irregular/incidental; P = Possible; H = Historic; * = Extirpated in parts

Arrow Boundary Forest District

Common Name	CCM	NKM	NOH	SCM	SFH	SOH
Amphibians						
Coeur d'Alene Salamander	X			X	X	
Great Basin Spadefoot			X		P	X
Tiger Salamander			X		P	X
Reptiles						
Great Basin Gopher Snake			X			X
Birds						
Interior Western Screech-Owl			X	X	X	X
Lewis's Woodpecker	X		X	X	X	X
Long-billed Curlew			X	X		X
Short-eared Owl			X	X	X	X
White-headed Woodpecker			X	X	X	X
Mammals						
Badger			X	X	X	X
Fringed Myotis			X		P	X
Grizzly Bear	X	X	*	X	X	
Mountain Caribou	X	X		X		
Wolverine	X	X	X	X	X	X

X = Present; T = Introduced; I = Irregular/incidental; P = Possible; H = Historic; * = Extirpated in parts

Cascades Forest District

Common Name	CCR	CPR	EPR	FRB	GUU	HOR	LPR	NIB	OKR	PAR	SCR	STU	THB
Amphibians													
Coastal Tailed Frog		X	X			X	X		X	X	X	X	
Great Basin Spadefoot				P					X	P		X	X
Reptiles													
Great Basin Gopher Snake				X					X	X		X	X
Birds													
Burrowing Owl				I				X	X			X	X
Flammulated Owl	X			X	X			X	X	X	X	X	X
Interior Western Screech-Owl					X			X	X			I	I
Lewis's Woodpecker	P			X	X			X	X	X	X	X	X
Long-billed Curlew				X	X			X	X	X		X	X
Spotted Owl			X			X	X						
White-headed Woodpecker									X			I	I
Yellow-breasted Chat				P					X				P
Mammals													
Badger				X		X			X	X		X	X
Fringed Myotis				X	X			X	X	P		X	X
Grizzly Bear	X	X	*	H	X	X	X	X	*	*	X	*	H
Spotted Bat				X					X	X	X	X	X
Wolverine	X	X	X	X	X	X	X	X	X	X	X	X	X

X = Present; T = Introduced; I = Irregular/incidental; P = Possible; H = Historic; * = Extirpated in parts

Central Cariboo Forest District

Common Name	BOV	CAB	CAM	CAP	CCR	CHP	FRB	NAU	QUH	QUL	SCR
Amphibians											
Great Basin Spadefoot		X		P		P	P				
Reptiles											
Great Basin Gopher Snake					P		X				
Birds											
Flammulated Owl		X			X	X	X			X	X
Lewis's Woodpecker		P		P	P	P	X			P	X
Long-billed Curlew		X		X		X	X			X	
Short-eared Owl		X			X	X	X			X	
Yellow-breasted Chat							P				
Mammals											
Badger		X		X		X	X				
Fringed Myotis		P				?	X				
Grizzly Bear	X	H	X	*	X	*	H	*	X	*	X
Mountain Caribou	X		X						X		
Spotted Bat		X				X	X				X
Wolverine	X	X	X	X	X	X	X	X	X	X	X

X = Present; T = Introduced; I = Irregular/incidental; P = Possible; H = Historic; * = Extirpated in parts

Chilcotin Forest District

Common Name	CCR	CHP	CPR	FRB	NAU	SCR	WCR	WCU
Birds								
Flammulated Owl	X	X		X		X		
Lewis's Woodpecker		X		P				
Long-billed Curlew		X		X				
Short-eared Owl	X	X		X				
Mammals								
Badger		X		X				
Fringed Myotis		P		X				
Grizzly Bear	X	*	X	H	*	X	X	X
Northern Caribou		X			X		X	X
Spotted Bat				X				
Wolverine	X	X	X	X	X	X	X	X

X = Present; T = Introduced; I = Irregular/incidental; P = Possible; H = Historic; * = Extirpated in parts

Columbia Forest District

Common Name	BBT	CCM	CPK	EPM	NKM	SPK	UCV
Amphibians							
Coeur d'Alene Salamander		X					
Northern Leopard Frog							H
Birds							
Lewis's Woodpecker		P		P		P	P
Short-eared Owl	P		P		P		
Mammals							
Badger				X		X	
Grizzly Bear	X	X	X	X	X	X	X
Mountain Caribou	X	X	X	X	X		
Wolverine	X	X	X	X	X	X	X

X = Present; T = Introduced; I = Irregular/incidental; P = Possible; H = Historic; * = Extirpated in parts

Headwaters Forest District

Common Name	BBT	CAM	CAP	CPK	NKM	NPK	NTU	QUH	SHH	SHR	UFT
Birds											
Lewis's Woodpecker			P				X				
Long-billed Curlew							X				X
Mammals											
Badger			X				X				
Grizzly Bear	X	X	*	X	X	X	*	X	X	X	X
Mountain Caribou	X	X		X	X	X		X	X		X
Wolverine	X	X	X	X	X	X	X	X	X	X	X

X = Present; T = Introduced; I = Irregular/incidental; P = Possible; H = Historic; * = Extirpated in parts

Kamloops Forest District

Common Name	CAB	CAP	GUU	NIB	NTU	PAR	SHB	SHH	STU	THB	TRU
Amphibians											
Great Basin Spadefoot	X	X			X	P	X		X	X	
Reptiles											
Great Basin Gopher Snake						X	X		X	X	
Birds											
Burrowing Owl				X					X	X	
Flammulated Owl	X		X	X	X	X	X		X	X	X
Interior Western Screech-Owl			X	X	X				I	I	I
Lewis's Woodpecker	P	P	X	X	X	X	X		X	X	X
Long-billed Curlew	X		X	X	X	X	X		X	X	
Sage Thrasher						X				X	
Short-eared Owl	X		X	X			X		X	X	
Yellow-breasted Chat										P	
Mammals											
Badger	X	X			X	X		X	X	X	
Fringed Myotis	P		X	X		P	X		X	X	
Grizzly Bear	H	*	X	X	*	*	X	X	*	H	X
Spotted Bat	X					X			X	X	
Wolverine	X	X	X	X	X	X	X	X	X	X	X

X = Present; T = Introduced; I = Irregular/incidental; P = Possible; H = Historic; * = Extirpated in parts

Kootenay Lake Forest District

Common Name	CCM	EPM	MCR	NKM	SCM	SPM
Amphibians						
Coeur d'Alene Salamander	X		X		X	X
Northern Leopard Frog					X	
Birds						
Interior Western Screech-Owl					X	X
Lewis's Woodpecker	X	X	X		X	X
Long-billed Curlew					X	
Short-eared Owl					X	X
White-headed Woodpecker					I	
Yellow-breasted Chat					P	
Mammals						
Badger		X	X		X	
Grizzly Bear	X	X	X	X	X	X
Mountain Caribou	X	X		X	X	
Wolverine	X	X	X	X	X	X

X = Present; T = Introduced; I = Irregular/incidental; P = Possible; H = Historic; * = Extirpated in parts

Okanagan Shuswap Forest District

Common Name	CCM	HOR	NKM	NOB	NOH	OKR	SFH	SHB	SHH	SOB	SOH	STU	THB
Amphibians													
Coastal Tailed Frog		X				X						X	
Great Basin Spadefoot				X	X	X	P	X		X	X	X	X
Northern Leopard Frog				H		H				H			
Tiger Salamander				X	X	X	P			X	X	X	
Reptiles													
Great Basin Gopher Snake				X	X	X		X		X	X	X	X
Birds													
Burrowing Owl				X	X	X				X	X	X	X
Flammulated Owl				X	X	X		X		X	X	X	X
Interior Western Screech-Owl				X	X	X		X		X	X	I	I
Lewis's Woodpecker	X			X	X	X	X	X		X	X	X	X
Long-billed Curlew				X	X	X		X		X	X	X	X
Sage Thrasher				X		X				X			X
Short-eared Owl				X	X	X	X	X		X	X	X	X
White-headed Woodpecker				X	X	X	X			X	X	I	I
Yellow-breasted Chat				X		X				X	X		P
Mammals													
Badger		X		X	X	X	X		X	X	X	X	X
Fringed Myotis				X	X	X	P	X		X	X	X	X
Grizzly Bear	X	X	X	H	*	*	X	X	X	H	H	*	H
Spotted Bat				X	P	X				X		X	X
Mountain Caribou	X		X						X				
Wolverine	X	X	X	X	X	X	X	X	X	X	X	X	X

X = Present; T = Introduced; I = Irregular/incidental; P = Possible; H = Historic; * = Extirpated in parts

Quesnel Forest District

Common Name	BOV	CAB	CAM	CAP	NAU	QUH	QUL	WCU
Birds								
Long-billed Curlew		X					X	
Short-eared Owl		X					X	
Mammals								
Badger		X		X				
Grizzly Bear	X	H	X	*	*	X	*	X
Mountain Caribou	X		X			X		
Northern Caribou					X			X
Wolverine	X	X	X	X	X	X	X	X

X = Present; T = Introduced; I = Irregular/incidental; P = Possible; H = Historic; * = Extirpated in parts

Rocky Mountain Forest District

Common Name	CCM	COC	EKT	ELV	EPM	FLV	MCR	NKM	SPK	SPM	UCV
Amphibians											
Coeur d'Alene Salamander	X						X			X	
Northern Leopard Frog			H			H					H
Rocky Mountain Tailed Frog						X	X			X	
Birds											
Burrowing Owl			I								
Flammulated Owl			X		X		X				X
Lewis's Woodpecker	X		X	X	X		X		X	X	X
Long-billed Curlew			X	X							X
Short-eared Owl			X							X	
Mammals											
Badger		X	X		X	X	X		X		
Grizzly Bear	X	X	X	X	X	X	X	X	X	X	X
Mountain Caribou	X				X			X			
Wolverine	X	X	X	X	X	X	X	X	X	X	X

X = Present; T = Introduced; I = Irregular/incidental; P = Possible; H = Historic; * = Extirpated in parts